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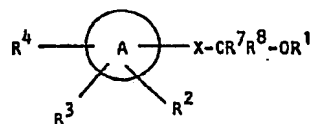
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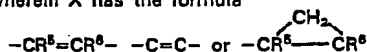
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Alkene, alkyne or cycloalkylene derivatives.

A compound of the formula

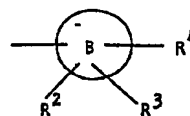


wherein X has the formula



wherein ring A is phenyl, naphthyl or heterocyclic; wherein R¹ is hydrogen, alkyl, alkanoyl or aroyl; wherein R², R³ and R⁴, which may be the same or different, each is an electron withdrawing substituent selected from halogeno, nitro, cyano, trifluoromethyl, alkylthio, alkylsulphinyl and alkylsulphonyl or each is hydrogen, alkyl, alkoxy or dialkylamino provided that when ring A is phenyl or naphthyl at least one of R², R³ and R⁴ is an electron-withdrawing substituent; wherein R⁵ and R⁶, which may be the same or different, each is hydrogen, halogeno or alkyl; wherein R⁷ is alkyl or

halogenoalkyl; and wherein R⁸ is carbamoyl, alkyl, cycloalkyl, alkenyl, alkynyl, halogenoalkyl, halogenoalkenyl, halogenoalkynyl, alkanoyl, alkylcarbamoyl, dialkylcarbamoyl or aroyl; or wherein R⁸ is alkyl or alkenyl which bears one or more substituents selected from cyano, carbamoyl, amino, hydroxy, alkanoyl, alkoxy, alkylthio, alkenylthio, alkylsulphinyl, alkenylsulphinyl, alkylsulphonyl, alkenylsulphonyl, alkanoylamino, alkoxy carbonylamino, alkylsulphonamido, alkylamino, dialkylamino dialkylsulphamoyl, aroyl, aryl, arylthio, arylsulphinyl, arylsulphonyl, heterocyclythio, heterocyclylsulphinyl and heterocyclylsulphonyl; or wherein R⁸ has the formula



wherein ring B is phenyl, naphthyl or heterocycl and wherein R², R³ and R⁴ have any of the meanings stated above, provided that when R⁷ is methyl R⁸ is not also methyl.

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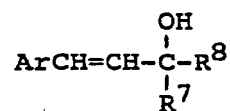
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ALKENE, ALKYNE OR CYCLOALKYLENE DERIVATIVES

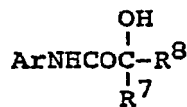
This invention relates to novel alkene, alkyne or cycloalkylene derivatives which possess antiandrogenic properties.

Various 4-arylbut-3-en-2-ol derivatives of the general formula:-



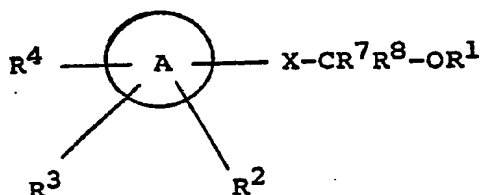
wherein Ar is a phenyl group bearing one or more electron-withdrawing substituents, are known, for a variety of purposes. For example, such compounds wherein R⁷ is t-butyl and R⁸ is imidazol-1-ylmethyl or 1,2,4-triazol-1-ylmethyl are known, from European Patent Specifications Nos 40345 and 52424 and other related specifications, as plant growth regulators or fungicides. When R⁷ and R⁸ are both methyl the compound wherein Ar is 3-nitrophenyl is known from United States Patent Specification No. 4139561, and the compound wherein Ar is 4-chlorophenyl is known from Synthesis, 1980, pages 815-816, in both cases the compounds being used as chemical intermediates. When R⁷ is methyl, R⁸ is carboxymethyl or ethoxycarbonylmethyl and Ar is 4-chlorophenyl, the compounds are described in Biochemistry, 1964, Volume 3, pages 1998 et seq., as potential (although inactive) inhibitors of cholesterol biosynthesis.

Various acylanilides of the general formula

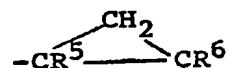
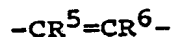


are known as antiandrogens. The compounds wherein R^7 and R^8 are both methyl and Ar is 4-nitro-3-trifluorophenyl is known as hydroxyflutamide, and is believed to be the active metabolite of the commercially-available antiandrogen FLUTAMIDE. Other acylanilides which possess antiandrogenic activity are known from European Specifications Nos 2309, 2892 and 40932, and from Japanese Specification No. 52-128329.

According to the present invention there is provided a compound of the formula



wherein X has the formula



or

wherein ring A is phenyl, naphthyl or heterocyclic; wherein R^1 is hydrogen, alkyl or alkanoyl each of up to 6 carbon atoms or aroyl of up to 10 carbon atoms; wherein R^2 , R^3 and R^4 , which may be the same or different, each is an electron withdrawing substituent selected from halogeno, nitro, cyano and trifluoromethyl, and alkylthio, alkylsulphanyl and alkylsulphonyl each of up to 6 carbon atoms, or each is hydrogen or alkyl, alkoxy or dialkylamino each of up to 6 carbon atoms, provided that when ring A is phenyl or naphthyl at least one of R^2 , R^3 and R^4 is an electron-withdrawing substituent;

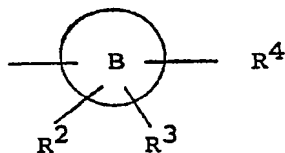
wherein R^5 and R^6 , which may be the same or different, each is hydrogen, halogeno or alkyl of up to 6 carbon atoms, ;

wherein R^7 is alkyl or halogenoalkyl each of up to 6 carbon atoms;

and wherein R^8 is carbamoyl, alkyl, cycloalkyl, alkenyl, alkynyl, halogenoalkyl, halogenoalkenyl, halogenoalkynyl or alkanoyl each of up to 6 carbon atoms, or alkyl-carbamoyl or dialkylcarbamoyl wherein each alkyl is of up to 6 carbon atoms, or aroyl of up to 10 carbon atoms;

or wherein R^8 is alkyl or alkenyl each of up to 6 carbon atoms which bears one or more substituents selected from cyano, carbamoyl, amino and hydroxy, alkanoyl, alkoxy, alkylthio, alkenylthio, alkylsulphinyl, alkenylsulphinyl, alkylsulphonyl, alkenylsulphonyl, alkanoylamino, alkoxycarbonylamino and alkylsulphonamido each of up to 6 carbon atoms, alkylamino, dialkylamino and dialkylsulphamoyl wherein each alkyl is of up to 6 carbon atoms, aroyl, aryl, arylthio, arylsulphinyl and arylsulphonyl each of up to 10 carbon atoms and heterocyclylthio, heterocyclylsulphinyl and heterocyclylsulphonyl;

or wherein R^8 has the formula



wherein ring B is phenyl, naphthyl or heterocyclyl and wherein R^2 , R^3 and R^4 have any of the meanings stated above, provided that when R^7 is methyl R^8 is not also methyl.

It will be observed that a compound of the invention wherein X is other than ethynylene may exist in two geometrical isomeric forms depending upon the

disposition of the various substituents about the olefinic or cycloalkyl bond -X-, and also that a compound of the invention wherein R^7 and R^8 are different one from the other possesses at least one asymmetric carbon atom, namely the carbon atom which bears the substituents R^7 , R^8 and $-OR^1$, and it can therefore exist in racemic and optically-active forms. It is to be understood that this invention encompasses either geometric isomer in racemic form, and any optically-active form of the compound which possesses antiandrogenic activity, it being a matter of common general knowledge how a racemic compound may be resolved into its optically-active forms and how any antiandrogenic activity present in any of these forms may be determined.

A suitable value for ring A or B when it is heterocyclyl, or for the heterocyclyl group in R^8 when it is or contains heterocyclyl or heterocyclylthio-, sulphinyl- or sulphonyl-, is, for example, 5- or 6-membered saturated or unsaturated heterocyclic which contains one, two or three hetero atoms selected from oxygen, nitrogen and sulphur, which heterocyclic is a single ring or is fused to one or two benzo-rings or to another heterocyclic ring as defined above, and which heterocyclic is unsubstituted or bears substituents R^2 , R^3 and R^4 as defined above, or when part of R^8 may also bear one or more hydroxy, mercapto or amino substituents.

Ring A when heterocyclic is preferably pyridyl, quinolyl or thienyl which is unsubstituted or bears one or two halogeno or cyano substituents, or one nitro substituent.

Ring B when heterocyclic is preferably pyridyl or thiazolyl which is unsubstituted or bears a halogeno or trifluoromethyl substituent, or is unsubstituted 1,3-dithian-2-yl.

When R^8 is alkyl or alkenyl bearing a heterocyclylthio, heterocyclylsulphiny or heterocyclylsulphonyl substituent the heterocyclyl group is preferably pyridyl, quinolyl, pyrimidyl, thiazolyl, imidazolyl, triazolyl, purinyl, pyrazolopyrimidyl or acridyl which is unsubstituted or bears one or more substituents selected from halogeno, trifluoromethyl, hydroxy, mercapto and amino, and alkyl and alkoxy each of up to 6 carbon atoms.

A suitable value for R^1 , R^2 , R^3 , R^4 , R^5 , R^6 , R^7 or R^8 when it is alkyl is, for example, methyl, ethyl, n-propyl, isopropyl, n-butyl or n-hexyl.

A suitable value for R^1 or R^8 when it is alkanoyl, or for the alkanoyl substituent in R^8 when R^8 is alkyl or alkenyl substituted by alkanoyl is, for example, formyl, acetyl or propionyl.

A suitable value for R^1 or R^8 when it is aroyl, or for the aroyl substituent in R^8 when R^8 is alkyl or alkenyl substituted by aroyl, is, for example, benzoyl or p-toluoyl.

A suitable value for R^2 , R^3 , R^4 , R^5 or R^6 when it is halogeno, or for the halogeno substituent in R^8 when R^8 is halogenoalkyl, halogenoalkenyl or halogenoalkynyl is, for example, fluoro, chloro or bromo.

A suitable value for R^2 , R^3 or R^4 when it is alkoxy, or for the alkoxy substituent in R^8 when R^8 is alkyl or alkenyl substituted by alkoxy is, for example, methoxy or ethoxy.

A suitable value for R^2 , R^3 or R^4 when it is alkylthio, alkylsulphiny or alkylsulphonyl, or for the alkylthio, alkylsulphiny or alkylsulphonyl substituent

in R^8 when R^8 is alkyl or alkenyl substituted by alkylthio, alkylsulphinyl or alkylsulphonyl is, for example, methylthio, ethylthio, n-propylthio, methylsulphinyl, ethylsulphinyl, n-propylsulphinyl, methylsulphonyl, ethylsulphonyl or n-propylsulphonyl.

A suitable value for R^2 , R^3 or R^4 when it is dialkylamino, or for the dialkylamino substituent in R^8 when R^8 is alkyl or alkenyl substituted by dialkylamino is, for example, dimethylamino or diethylamino.

A suitable value for R^8 when it is alkylcarbamoyl or dialkylcarbamoyl, is, for example, methylcarbamoyl or dimethylcarbamoyl.

A suitable value for R^7 or R^8 when it is halogenoalkyl is, for example, trifluoromethyl, pentafluoroethyl, heptafluoropropyl, chloromethyl or dichloromethyl.

A suitable value for R^8 when it is cycloalkyl, alkenyl or alkynyl is, for example, cyclopropyl, cyclopentyl, vinyl, allyl or ethynyl.

A suitable value for the alkoxy-carbonylamino, alkanoylamino, alkylsulphonamido, alkylamino or dialkylsulphamoyl substituent in R^8 when R^8 is alkyl or alkenyl which bears such a substituent is, for example, methoxycarbonylamino, ethoxycarbonylamino, acetamido, methylsulphonamido, methylamino, ethylamino or dimethylsulphamoyl.

A suitable value for the aryl, arylthio, arylsulphinyl or arylsulphonyl substituent in R^8 when R^8 is alkyl or alkenyl which bears such a substituent is,

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for example, phenyl, tolyl, fluorophenyl, chlorophenyl, nitrophenyl, methylthiophenyl, methylsulphonylphenyl, carbamoylphenyl, acetamidophenyl or dimethylaminophenyl, or the corresponding phenylthio, phenylsulphinyl, phenylsulphonyl or substituted phenylthio, phenylsulphinyl or phenylsulphonyl.

A suitable value for the alkenylthio, alkenylsulphinyl or alkenylsulphonyl substituent in R^8 when R^8 is alkyl or alkenyl which bears such a substituent is, for example, allylthio, allylsulphinyl or allylsulphonyl.

A preferred compound of the invention has the formula stated above wherein X is $-CR^5=CR^6-$, wherein ring A is phenyl, wherein one or two (the same or different) of R^2 , R^3 and R^4 are fluoro, chloro, cyano, trifluoromethyl or nitro, the others of R^2 , R^3 and R^4 being hydrogen, wherein R^1 , R^5 and R^6 are all hydrogen, wherein R^7 is trifluoromethyl, pentafluoroethyl, heptafluoropropyl, chloromethyl or dichloromethyl, wherein R^8 is methyl, ethyl, n-propyl, isopropyl, n-butyl, cyclopropyl, trifluoromethyl, chloromethyl, dichloromethyl, ethynyl, chloroethynyl, acetyl or propionyl or is methylene ($-CH_2-$) substituted by cyano, hydroxy, carbamoyl, formyl, acetyl, alkylthio, alkenylthio, alkylsulphonyl or alkenylsulphenyl each of up to 6 carbon atoms, phenylthio or phenylsulphonyl which itself is unsubstituted or bears a fluoro, chloro, nitro, carbamoyl, acetamido, methylthio or methylsulphonyl substituent, pyridyl, quinolyl, pyrimidinyl, purinyl, pyrazolopyrimidinyl, thiazolyl, imidazolyl or triazolyl any of which is unsubstituted or bears a hydroxy, mercapto, amino, chloro, trifluoromethyl or methyl substituent, and wherein the $-CR^5=CR^6-$ group is in the trans- configuration.

A particularly preferred compound of the invention has the formula stated above wherein X is

trans- -CH=CH-, wherein ring A is 3,4-dichlorophenyl, 3-chloro-4-cyanophenyl, 3-chloro-4-fluorophenyl, 4-chloro-3-trifluoromethylphenyl, 4-cyanophenyl, 4-cyano-3-fluorophenyl, 4-cyano-3-trifluoromethylphenyl or 4-fluoro-3-trifluoromethylphenyl, wherein R¹ is hydrogen, wherein R⁷ is trifluoromethyl and wherein R⁸ is ethyl, ethynyl, cyanomethyl, 1-cyanoethyl, acetyl, methylsulphonylmethyl, p-methylsulphonylphenylsulphonylmethyl or pyrid-2-ylsulphonyl, or has the formula -CH₂SR⁹ wherein R⁹ is m-methylthiophenyl, pyrid-4-yl, pyrimid-2-yl, 4,6-dimethylpyrimid-2-yl, purin-6-yl, 1H-pyrazolo[3,4-d]pyrimidin-4-yl, imidazol-2-yl, 1-methylimidazol-2-yl, 7-chloroquinolin-4-yl or 7-trifluoromethylquinolin-4-yl.

Specific compounds of the invention are hereinafter described in the Examples. Of these, preferred compounds by virtue of their high level of antiandrogenic activity are:-

5-(3,4-dichlorophenyl)-3-hydroxy-3-trifluoromethylpent-trans-4-en-2-one;

5-(3,4-dichlorophenyl)- and 5-(4-cyano-3-trifluoromethylphenyl)-3-trifluoromethylpent-trans-4-en-1-yn-3-ol;

5-(4-cyanophenyl)- and 5-(4-cyano-3-trifluoromethylphenyl)-3-hydroxy-3-trifluoromethylpent-trans-4-enenitrile;

4-(3-chloro-4-fluorophenyl-, 4-cyanophenyl-, 4-cyano-3-trifluoromethylphenyl-, 4-chloro-3-trifluoromethylphenyl and 4-fluoro-3-trifluoromethylphenyl)-1-methylsulphonyl-2-trifluoromethylbut-trans-3-en-2-ol;

5-(3,4-dichlorophenyl)-3-hydroxy-2-methyl-3-trifluoromethylpent-trans-4-enenitrile;

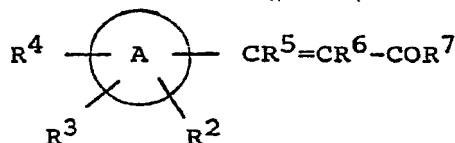
4-(3,4-dichlorophenyl)-1-(pyrid-4-ylthio)-2-trifluoromethylbut-trans-3-en-2-ol;

4-(3,4-dichlorophenyl)-1-(pyrimidin-2-ylthio)-2-trifluoromethylbut-trans-3-en-2-ol;

4-(3,4-dichlorophenyl)-1-(pyrid-2-ylsulphonyl)-2-tri-
fluoromethylbut-trans-3-en-2-ol;
4-(4-cyano-3-trifluoromethylphenyl)-1-(7-chloroquinolin-
4-ylthio)-, 1-(7-trifluoromethylquinolin-4-ylthio)-,
5 1-(pyrimidin-2-ylthio)-, 1-(4,6-dimethylpyrimidin-2-
ylthio)-, 1-(purin-6-ylthio)-, 1-(1H-pyrazolo[3,4-d]-
pyrimidin-4-ylthio)-1-(imidazol-2-ylthio)- and
1-(1-methylimidazol-2-ylthio)-2-trifluoromethylbut-trans-
3-en-2-ol;
10 5-(3,4-dichlorophenyl)- and 5-(4-cyano-3-trifluoro-
methylphenyl)-3-trifluoromethylpent-trans-3-en-2-ol;
4-(3-chloro-4-cyanophenyl)-1-(m-methylthiophenyl)thio-2-
trifluoromethylbut-trans-3-en-2-ol; and
4-(3-chloro-4-cyanophenyl)-1-(p-methylsulphonylphenyl-
sulphonyl)-2-trifluoromethylbut-trans-3-en-2-ol.

A compound of the invention may be
manufactured by any chemical process known to be
suitable for the manufacture of chemically-analogous
compounds.

20 One process for the manufacture of an alkene
of the invention wherein R^1 is hydroxy and X is
- $CR^5=CR^6$ - comprises the reaction of a compound of the
formula:

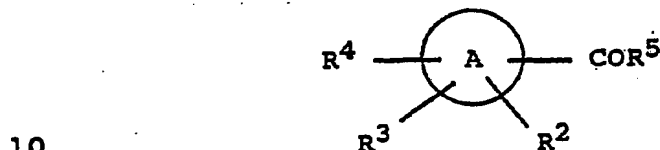


30 wherein A, R^2 , R^3 , R^4 , R^5 , R^6 and R^7 have the meanings
stated above, with an organometallic compound of the
formula R^8-M , wherein R^8 has the meaning stated above
and M is a metallic group.

35 M may be, for example, lithium, and the

reaction is preferably carried out in an inert diluent or solvent, for example tetrahydrofuran, at a reduced temperature, for example at -70°C to -80°C .

5 The starting material for the abovementioned reaction may be obtained by the reaction of an aldehyde or ketone of the formula:

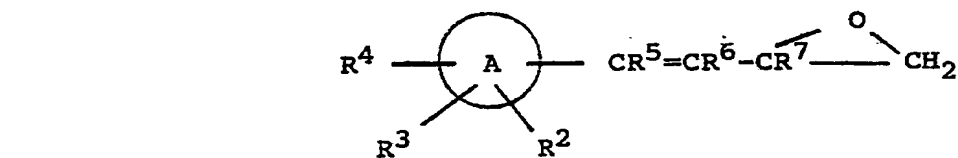


wherein A, R^2 , R^3 , R^4 and R^5 have the meanings stated above, with a compound of the formula

15 $R^6\text{CH}_2\text{COR}^7$ or $(\text{Ph})_3\text{P}=\text{CR}^6\text{COR}^7$ or $(\text{EtO})_2\text{POCHR}^6\overset{\text{NMe}}{\underset{\parallel}{\text{C}}}-\text{R}^7$ wherein R^6 and R^7 have the meanings stated above.

An alternative process for the manufacture of an alkene of the invention wherein R^1 is hydroxy, X is $-\text{CR}^5=\text{CR}^6-$, and R^8 has the formula $-\text{CH}_2\text{R}^9$ comprises the reaction of an epoxide of the formula:

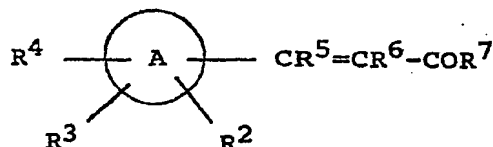
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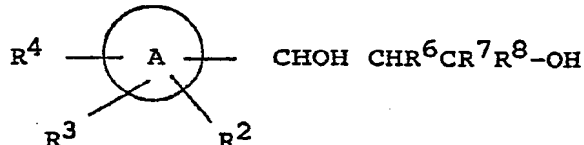
wherein A, R^2 , R^3 , R^4 , R^5 , R^6 and R^7 have the meanings stated above, with a compound of the formula $R^9-\text{H}$, wherein R^9 is such that $-\text{CH}_2\text{R}^9$ has the meaning stated above for R^8 .

30 The abovementioned reaction is particularly suitable for the manufacture of an alkene of the invention wherein $R^9-\text{H}$ contains a reactive thiol group, or wherein the $-\text{H}$ atom is otherwise reactive. The

The epoxide starting material may be obtained by the reaction of a compound of the formula:

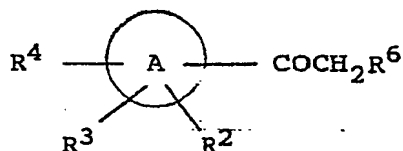


An alternative process for the manufacture of an alkene of the invention wherein R^1 and R^5 are both hydrogen and X is $-CH=CR^6-$ comprises the dehydration of a compound of the formula



The dehydration may be carried out under acidic conditions, for example by heating with p-toluenesulphonic acid.

The starting material may be obtained by reacting a compound of the formula

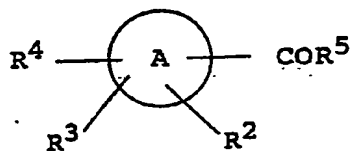


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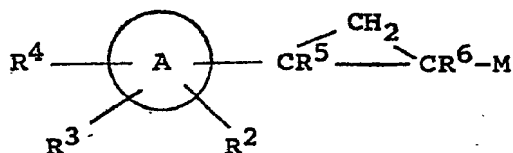
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derivative of the invention wherein X is $-\text{CR}^5-\overset{\text{CH}_2}{\text{---}}-\text{CHR}^6$
comprises the reaction of a compound of the formula



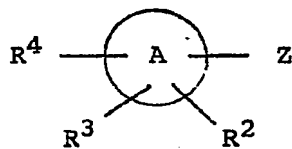
wherein A, R², R³, R⁴, R⁵, R⁶ and M have the meanings stated above, with a compound of the formula



wherein R⁷ and R⁸ have the meanings stated above.

This reaction may be carried out at a low temperature in an inert diluent or solvent. M is preferably lithium.

A process for the manufacture of an alkyne of the invention wherein X is -C≡C- comprises the reaction of a compound of the formula



wherein A, R¹, R², R³ and R⁴ have the meanings stated above and wherein Z is a displaceable group, with a compound of the formula



wherein R¹, R⁷ and R⁸ have the meanings stated above.

A suitable value for Z is, for example, an iodo group.

A compound of the invention wherein X is $-C\equiv C-$ may be reduced to the corresponding compound of the invention wherein X is $-CH=CH-$. Conventional conditions for the reduction may be chosen so that either the cis- or trans- alkene is obtained.

Various interconversions of compounds of the invention wherein R^8 has different meanings are possible. Thus, for example

- (i) a compound wherein R^8 bears an amino substituent may be acylated to give the corresponding compound wherein R^8 bears an alkanoylamino, alkoxycarbonylamino or alkylsulphonamido substituent;
- (ii) a compound wherein R^8 is alkyl containing an alkylthio and an alkylsulphinyl substituent on the same carbon atom may be converted to the corresponding compound wherein said carbon atom is a carbonyl group;
- (iii) a compound wherein R^8 is alkanoyl or is alkyl substituted by alkanoyl may be reduced to the corresponding compound wherein R^8 is hydroxyalkyl; or
- (iv) a compound wherein R^8 is alkynyl may be converted to the corresponding compound wherein R^8 is alkanoyl by hydration by conventional means, for example with mercuric oxide.

A compound of the invention wherein R^1 is alkyl may be prepared by the alkylation of the corresponding compound wherein R^1 is hydrogen.

A compound of the invention wherein R^1 is alkanoyl or aroyl may be prepared by the acylation of the corresponding compound wherein R^1 is hydrogen.

A compound of the invention wherein one or more of R^2 , R^3 , R^4 and a substituent in R^8 is alkylsulphinyl or alkylsulphonyl, or a substituent in R^8 is alkenylsulphinyl, arylsulphinyl, alkenylsulphonyl, arylsulphonyl, heterocyclylsulphinyl or heterocyclylsulphonyl, may be prepared by the oxidation of the corresponding compound wherein one or more of R^2 ,

R^3 , R^4 and a substituent in R^8 is alkylthio, alkenylthio, arylthio or heterocyclylthio, respectively. The oxidising agent and conditions used will determine whether a sulphinyl or a sulphonyl compound is obtained. Thus, oxidation with sodium metaperiodate in methanol solution at or below laboratory temperature will generally convert a thio compound into the corresponding sulphinyl compound; and oxidation with hydrogen peroxide in acetic acid solution or with a persulphate in aqueous solution at or above laboratory temperature, will generally convert a thio compound into the corresponding sulphonyl compound, although this reaction occasionally stops at the sulphinyl stage.

As stated above, a compound of the invention possesses antiandrogenic properties as demonstrated by its ability to decrease the weight of the seminal vesicles of a castrated male rat when administered concurrently with testosterone propionate. A compound of the invention may therefore be used in the treatment of, for example, malignant or benign prostatic disease or of androgen dependent disease conditions, such as acne, hirsutism or seborrhoea, in warm-blooded vertebrates including man. It may also be used to improve ovulation in a domestic animal.

At a dose of a compound of the invention which produces antiandrogenic activity in rats no symptom of toxicity is apparent.

The compound of the invention may be administered to a warm-blooded animal in the form of a pharmaceutical or veterinary composition which comprises the compound in association with a pharmaceutically-acceptable diluent or carrier.

The composition may be in a form suitable for oral dosage, as a tablet, capsule, aqueous or oily solution or suspension, or emulsion. It may

alternatively be in the form of a sterile solution or suspension suitable for parenteral administration, or be in the form of an ointment or lotion for topical administration, or be in the form of a suppository.

5 The composition may additionally contain one or more drugs selected from anti-oestrogens, for example tamoxifen; aromatase inhibitors, for example testolactone or aminoglutethimide; progestins, for example medroxyprogesterone acetate; inhibitors of
10 gonadotrophin secretion, for example danazol; LH-RH analogues, for example buserelin; cytotoxic agents, for example cyclophosphamide; antibiotics, for example penicillin or oxytetracyclin; and anti-inflammatory agents, for example, especially for topical use,
15 fluocinolone acetonide.

The compound of the invention will normally be administered to a warm-blooded animal at a dose of between 0.1 mg. and 125 mg. per kg. bodyweight.

The invention is illustrated but not
20 limited by the following Examples:-

Example 1

n-Butyl-lithium (2.1 ml. of a 1.6 molar solution in hexane) was added dropwise to a stirred solution of dimethyl sulphone (0.31 g.) in
25 tetrahydrofuran (50 ml.) which was cooled to $-78^{\circ}\text{C}.$, and the mixture was stirred for 1 hour. A solution of 1,1,1-trifluoro-4-(3,4-dichlorophenyl)but-trans-3-ene-2-one (0.75 g.) in tetrahydrofuran (25 ml.) was added dropwise, the mixture was stirred at $-78^{\circ}\text{C}.$ for 20
30 minutes, and a mixture of methanol (10 ml.) and saturated aqueous ammonium chloride solution (20 ml.) was added. The mixture was allowed to warm up to laboratory temperature and poured into water, and the mixture was extracted with ethyl acetate. The extract
35 was washed with water and then with saturated aqueous

sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using methylene chloride as eluant, and there was thus obtained 4-(3,4-dichlorophenyl)-1-methylsulphonyl-2-trifluoromethylbut-trans-3-en-2-ol, m.p. 110°C.

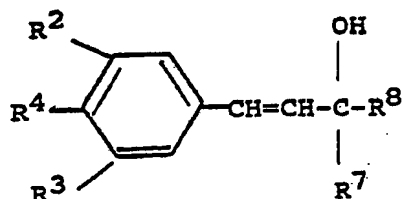
The 1,1,1-trifluoro-4-(3,4-dichlorophenyl)but-trans-3-ene-2-one used as starting material was obtained as follows:-

A solution of 3,4-dichlorobenzaldehyde (10 g.) in ethanol (50 ml.), and then 1,1,1-trifluoroacetone (6.5 ml.), were successively added to a stirred suspension of freshly ground lithium hydroxide monohydrate (1.0 g.) in ethanol (100 ml.), the trifluoroacetone being added by injection below the surface of the reaction mixture, and the mixture was stirred for 1 hour and then poured into water (600 ml.). The mixture was extracted with ethyl acetate and the extract was washed with aqueous 2N-hydrochloric acid and then saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using a 7:3 v/v mixture of petroleum ether (b.p. 60-80°C.) and methylene chloride as eluant. There was thus obtained 1,1,1-trifluoro-4-(3,4-dichlorophenyl)but-trans-3-en-2-one, m.p. 81°C.

Example 2

The process described in Example 1 was repeated using the appropriate organometallic compound and the appropriate 4-arylbut-trans-3-en-2-one as starting materials, and there were thus obtained the compounds described in the following tables:-

5



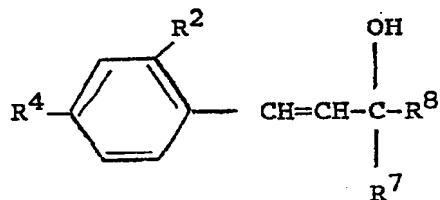
	R ²	R ³	R ⁴	R ⁷	R ⁸	m.p. (°C.)	Note
10	H	H	F	CF ₃	CH ₂ SO ₂ CH ₃	116	
	H	H	CN	CF ₃	CH ₂ SO ₂ CH ₃	156	
	H	CF ₃	F	CF ₃	CH ₂ SO ₂ CH ₃	126	
	H	Cl	F	CF ₃	CH ₂ SO ₂ CH ₃	95	
	H	H	NO ₂	CF ₃	CH ₂ SO ₂ CH ₃	(oil)	
15	H	CF ₃	Cl	CF ₃	CH ₂ SO ₂ CH ₃	136	
	Cl	Cl	H	CF ₃	CH ₂ SO ₂ CH ₃	132	
	H	CF ₃	H	CF ₃	CH ₂ SO ₂ CH ₃	89-92	
	H	CF ₃	CN	CF ₃	CH ₂ SO ₂ CH ₃	173-174	9
20	H	Cl	CN	CF ₃	CH ₂ SO ₂ CH ₃	115	9
	H	CH ₃ O	CN	CF ₃	CH ₂ SO ₂ CH ₃	134-136	
	H	CN	H	CF ₃	CH ₂ SO ₂ CH ₃	150-154	
	H	F	CN	CF ₃	CH ₂ SO ₂ CH ₃	150-151	9
	H	CF ₃	NO ₂	CF ₃	CH ₂ SO ₂ CH ₃	121-122	
25	H	Cl	Cl	C ₂ F ₅	CH ₂ SO ₂ CH ₃	94-95	6
	H	Cl	Cl	C ₃ F ₇	CH ₂ SO ₂ CH ₃	104-105	6
	H	CF ₃	CN	CH ₃	CH ₂ SO ₂ CH ₃	110-111	6, 9
	H	Cl	Cl	CH ₂ Cl	CH ₂ SO ₂ CH ₃	113	3
	H	H	CN	CF ₃	CH ₂ SO ₂ C ₂ H ₅	138	
30	H	Cl	CN	CF ₃	CH ₂ SO ₂ C ₂ H ₅	125	9
	H	CF ₃	CN	CF ₃	CH ₂ SO ₂ C ₂ H ₅	163	9

	R ²	R ³	R ⁴	R ⁷	R ⁸	m.p. (°C.)	Note
	H	Cl	F	CF ₃	CH ₂ SO ₂ C ₂ H ₅	88	
	H	Cl	Cl	CF ₃	CH ₂ SO ₂ N(CH ₃) ₂	106	1
5	H	CF ₃	Cl	CF ₃	CH ₂ SO ₂ N(CH ₃) ₂	102	1
	H	CF ₃	CN	CF ₃	CH ₂ SO ₂ N(CH ₃) ₂	160	1, 9
	H	Cl	Cl	CF ₃	CH ₂ SO ₂ C ₆ H ₅	102	
	H	CF ₃	CN	CF ₃	CH ₂ SO ₂ C ₆ H ₅	106	9
	H	Cl	CN	CF ₃	CH ₂ SO ₂ (4-fluoro-	(oil)	9
10					phenyl)		
	H	CF ₃	CN	CF ₃	CH ₂ SO ₂ (4-fluoro-	138	9
					phenyl)		
	H	Cl	Cl	CF ₃	CH ₂ CN	116	1
	H	NO ₂	Cl	CF ₃	CH ₂ CN	111	1
15	H	H	CN	CF ₃	CH ₂ CN	(oil)	1
	H	Cl	F	CF ₃	CH ₂ CN	86	1
	H	CF ₃	Cl	CF ₃	CH ₂ CN	(oil)	1
	H	CF ₃	NO ₂	CF ₃	CH ₂ CN	99-101	1
	H	CF ₃	CN	CF ₃	CH ₂ CN	117-118	1, 9
20	H	CN	Cl	CF ₃	CH ₂ CN	(oil)	1
	H	CF ₃	F	CF ₃	CH ₂ CN	(oil)	1
	H	Cl	Cl	C ₂ F ₅	CH ₂ CN	(oil)	1, 6
	H	Cl	Cl	C ₃ F ₇	CH ₂ CN	(oil)	1, 6
	H	Cl	Cl	CH ₃	CH ₂ CN	(oil)	1, 6
25	H	Cl	Cl	CHCl ₂	CH ₂ CN	77	1, 4
	H	Cl	Cl	CF ₃	CH(CH ₃)CN	86	1(Isomer A)
	H	Cl	Cl	CF ₃	CH(CH ₃)CN	129	1(Isomer B)
	H	H	CN	CF ₃	CH(CH ₃)CN	(oil)	1(Isomer A)
	H	H	CN	CF ₃	CH(CH ₃)CN	112	1(Isomer B)
30	H	CF ₃	Cl	CF ₃	CH(CH ₃)CN	97	1(Isomer A)
	H	CF ₃	Cl	CF ₃	CH(CH ₃)CN	78	1(Isomer B)
	H	Cl	F	CF ₃	CH(CH ₃)CN	79	1(Isomer A)
	H	Cl	F	CF ₃	CH(CH ₃)CN	84	1(Isomer B)
	H	CF ₃	CN	CF ₃	CH(CH ₃)CN	(oil)	1, 9
35							(Isomer A)

	R ²	R ³	R ⁴	R ⁷	R ⁸	m.p. (°C.)	Note
	H	CF ₃	CN	CF ₃	CH(CH ₃)CN	(oil)	1, 9
							(Isomer B)
5	H	Cl	Cl	CF ₃	CH(C ₂ H ₅)CN	88	1 (Isomer A)
	H	Cl	Cl	CF ₃	CH(C ₂ H ₅)CN	108	1 (Isomer B)
	H	Cl	Cl	CF ₃	C(CH ₃) ₂ CN	(oil)	1
	H	Cl	Cl	CF ₃	ethynyl	41	5
	H	H	CN	CF ₃	ethynyl	83	5
10	H	CF ₃	F	CF ₃	ethynyl	(oil)	5
	H	F	F	CF ₃	ethynyl	(oil)	5
	H	Cl	F	CF ₃	ethynyl	(oil)	5
	H	CF ₃	Cl	CF ₃	ethynyl	(oil)	5
	H	CF ₃	NO ₂	CF ₃	ethynyl	(oil)	5
15	Cl	Cl	H	CF ₃	ethynyl	(oil)	5
	H	CF ₃	H	CF ₃	ethynyl	(oil)	5
	H	CF ₃	CN	CF ₃	ethynyl	121-123	5, 9
	H	CN	H	CF ₃	ethynyl	(oil)	5
	H	CN	Cl	CF ₃	ethynyl	(oil)	5
20	H	Cl	Cl	C ₂ F ₅	ethynyl	(oil)	5, 6
	H	CN	H	CH ₃	ethynyl	(oil)	5, 6
	H	CF ₃	CN	CH ₃	ethynyl	(oil)	5, 6
	H	Cl	Cl	CH ₂ Cl	ethynyl	(oil)	3, 5
	H	Cl	Cl	CHCl ₂	ethynyl	(oil)	4, 5
25	H	Cl	Cl	CF ₃	chloroethynyl	78	
	H	Cl	Cl	CF ₃	methyl	(oil)	
	H	Cl	Cl	CF ₃	n-butyl	(oil)	
	H	Cl	Cl	CF ₃	cyclopropyl	48-50	
	H	Cl	Cl	CF ₃	allyl	(oil)	
30	H	Cl	Cl	CF ₃	CHCl ₂	49	1
	H	Cl	Cl	CF ₃	CF=CF ₂	60	2
	H	Cl	Cl	CF ₃	CH ₂ COCH ₃	91	1
	H	Cl	Cl	CF ₃	CH ₂ CONH ₂	126	8
	H	H	CN	CF ₃	C(OCH ₃)=CH ₂	(oil)	7

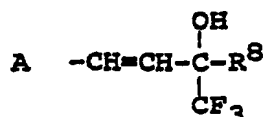
	R ²	R ³	R ⁴	R ⁷	R ⁸	m.p.(°C.)	Note
	H	Cl	Cl	CF ₃	C(SC ₆ H ₅)CH ₂	(oil)	
	H	Cl	Cl	CF ₃	CH(SCH ₃)SOCH ₃	75	
	H	Cl	Cl	CF ₃	C(C ₂ H ₅)(SCH ₃)SOCH ₃	(oil)	
	H	Cl	Cl	CF ₃	1,3-dithian-2-yl	110	
	H	Cl	Cl	CF ₃	6-fluoropyrid-3-yl	92	2
	H	Cl	Cl	CF ₃	4-trifluoromethyl-	81	
					thiazol-2-yl		
0	H	Cl	Cl	CF ₃	4-dimethylamino-	130	2
					phenyl		
	H	Cl	Cl	CF ₃	4-cyanophenyl	(oil)	
	H	Cl	Cl	CH ₃	4-cyanophenyl	75	6

5



0

	R ²	R ⁴	R ⁷	R ⁸	m.p.(°C.)	Note
	F	F	CF ₃	CH ₂ SO ₂ CH ₃	145	
5	F	F	CF ₃	ethynyl	(oil)	5



5	A	R ⁸	m.p. (°C.)	Note
	pyrid-3-yl	CH ₂ CN	(oil)	1
	pyrid-4-yl	CH ₂ CN	(oil)	1
10	6-chloropyrid-3-yl	CH ₂ CN	(oil)	1
	quinolin-3-yl	CH ₂ CN	(oil)	1
	5-bromothien-2-yl	CH ₂ CN	(oil)	1
	pyrid-4-yl	CH ₂ SO ₂ CH ₃	(oil)	
	6-chloropyrid-3-yl	CH ₂ SO ₂ CH ₃	(oil)	
15	4,5-dichlorothien-2-yl	CH ₂ SO ₂ CH ₃	(oil)	
	4,5-dichlorothien-2-yl	ethynyl	(oil)	5
	6-chloropyrid-3-yl	ethynyl	(oil)	5
	2-chloropyrid-4-yl	ethynyl	(oil)	5

25 Unless otherwise stated the 4-arylbut-trans-3-en-2-one used as starting material was prepared by the process described in the second part of Example 1 using the appropriate benzaldehyde or heterocyclic aldehyde and trifluoroacetone.

30 Unless otherwise stated the organometallic compound used as starting material was prepared by the reaction of the corresponding compound of the formula R⁸-H with n-butyl-lithium as described in the first part of Example 1.

35 Note 1 Lithium diisopropylamide was used in place of n-butyl-lithium.

Note 2 n-Butyl-lithium was reacted with a compound of the formula R⁸-Br in place of R⁸-H.

Note 3 The butenone starting material was obtained by the reaction of 3,4-dichlorobenzaldehyde (1.75 g.) and (3-chloroacetylidenetriphenylphosphorane (1.76 g.) in toluene (25 ml.) solution at 80°C. for 3 hours, evaporation to dryness, extraction of the residue with cyclohexane and purification of the extracted product by chromatography on a silica gel column using a 7:3 v/v mixture of petroleum ether (b.p. 60-80°C.) and methylene chloride. 1-Chloro-4-(3,4-dichlorophenyl)but-trans-3-en-2-one has m.p. 72°C.

Note 4 The butenone starting material was obtained by the reaction of 3,4-dichlorobenzaldehyde (0.34 g.) and (3,3-dichloroacetylidenetriphenylphosphorane (0.15g.) at 135°C. under an atmosphere of argon for 2 hours, followed by isolation and chromatographic purification by a similar procedure to that described under Note 3. 1,1-Dichloro-4-(3,4-dichlorophenyl)but-trans-3-en-2-one has m.p. 114°C.

Note 5 The butenone was reacted with trimethylsilylacetylene and the trimethylsilyl protecting group was removed by stirring the reaction product with tetra-n-butylammonium fluoride in tetrahydrofuran solution at laboratory temperature.

Note 6 The appropriate ketone (acetone, methyl pentafluoroethyl ketone or methyl heptafluoropropyl ketone) was used in place of trifluoroacetone in the preparation of the starting materials.

Note 7 t-Butyl-lithium was used in place of n-butyl-lithium.

Note 8 The butenone was reacted with N,N-bis-trimethylsilylacetamide, the trimethylsilyl protecting groups being removed during the work-up of the reaction product without a specific deprotection step being necessary.

Note 9 The butenone starting material was obtained by the reaction of the appropriate aldehyde with diethyl 3,3,3-trifluoro-2-methyliminopropylphosphonate by the method described in Tetrahedron Letters (1983), page 4229. 4-(4-Cyano-3-trifluoromethylphenyl)-1,1,1-trifluorobut-3-en-2-one has m.p. 119-121°C., 4-(4-cyano-3-fluorophenyl)-1,1,1-trifluorobut-3-en-2-one has m.p. 69-70°C., and 4-(3-chloro-4-cyanophenyl)-1,1,1-trifluorobut-3-en-2-one has m.p. 102-104°C.

Example 3

A solution of 4-(3,4-dichlorophenyl)-1,2-epoxy-2-trifluoromethylbut-trans-3-ene (1.27 g.) in tetrahydrofuran (20 ml.) was added dropwise to a stirred mixture of pyridine-2-thiol (0.5 g.), sodium hydride (0.22 g. of a 50% dispersion in mineral oil) and tetrahydrofuran (20 ml.), and the mixture was stirred at laboratory temperature for 1 hour and then poured into water. The mixture was extracted with ethyl acetate and the extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using a 3:2 v/v mixture of petroleum ether (b.p. 60-80°C.) and methylene chloride as eluant. There was thus obtained 4-(3,4-dichlorophenyl)-1-(pyrid-2-yl-thio)-2-trifluoromethylbut- trans-3-en-2-ol, m.p. 64°C.

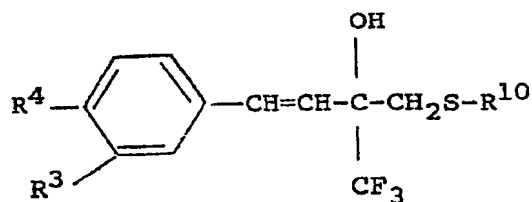
The epoxybutene used as starting material was obtained as follows:-

n-Butyl-lithium (11.6 ml. of a 1.6 molar solution in hexane) was added dropwise to a stirred suspension of trimethylsulphoxonium iodide (4.1 g.) in tetrahydrofuran (200 ml.) which was cooled to -10°C., and the mixture was stirred at that temperature for 2 hours and then added to a stirred solution of 4-(3,4-dichlorophenyl)-1,1,1-trifluorobut-trans-3-en-2-one

(Example 1; 2.0 g.) in tetrahydrofuran (100 ml.). The mixture was stirred for 90 minutes, saturated aqueous ammonium chloride solution (75 ml.) was added and the mixture was partitioned between water and ethyl acetate.

The layers were separated, the aqueous layer was extracted with ethyl acetate and the combined ethyl acetate solutions were washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using a 4:1 v/v mixture of petroleum ether (b.p. 60-80°C.) and methylene chloride as eluant. There was thus obtained as an oil 4-(3,4-dichlorophenyl)-1,2-epoxy-2-trifluoromethyl-but-trans-3 ene.

The process described above was repeated using as starting materials the appropriate thiol and the appropriate epoxide, prepared as described above from the appropriate butenone either as described in Example 1 or by the method generally described in Angewandte Chemie (International Edition), 1973, Volume 12, page 845. There were thus obtained the compounds described in the following table:-



R ³	R ⁴	R ¹⁰	m.p. (°C.)
Cl	Cl	ethyl	(oil)
Cl	Cl	n-propyl	(oil)
Cl	CN	n-butyl	(oil)

	R ³	R ⁴	R ¹⁰	m.p. (°C.)
	C1	C1	allyl	(oil)
	C1	C1	4-fluorophenyl	(oil)
5	H	CN	4-fluorophenyl	(oil)
	C1	CN	4-fluorophenyl	110
	C1	C1	4-chlorophenyl	(oil)
	C1	C1	4-nitrophenyl	(oil)
	C1	C1	3-methylthiophenyl	(oil)
10	C1	CN	3-methylthiophenyl	77
	CF ₃	CN	3-methylthiophenyl	109
	C1	CN	4-methylthiophenyl	73
	CF ₃	CN	4-methylthiophenyl	(oil)
	C1	C1	3-methylsulphonylphenyl	(oil)
15	CF ₃	CN	3-methylsulphonylphenyl	58
	CF ₃	CN	4-dimethylaminophenyl	110-111
	C1	C1	4-acetamidophenyl	55
	CF ₃	CN	4-acetamidophenyl	58-61
	C1	C1	4-carboxamidophenyl	(oil)
20	CF ₃	CN	4-carboxamidophenyl	(oil)
	CF ₃	CN	2-pyridyl	(oil)
	H	CN	2-pyridyl	(oil)
	CF ₃	CN	3-pyridyl	(oil)
	C1	C1	3-pyridyl	164
25	C1	C1	4-pyridyl	168
	CF ₃	C1	4-pyridyl	191
	CF ₃	CN	4-pyridyl	193-195
	C1	F	4-pyridyl	142
30	C1	C1	2-quinolyl	148
	C1	C1	4-quinolyl	126
	CF ₃	CN	8-quinolyl	78
	C1	C1	2-methyl-4-quinolyl	172
	C1	C1	7-chloro-4-quinolyl	191
35	CF ₃	CN	7-chloro-4-quinolyl	(oil)

	R ³	R ⁴	R ¹⁰	m.p. (°C.)
	Cl	Cl	7-trifluoromethyl-4-quinolyl	135
5	Cl	CN	7-trifluoromethyl-4-quinolyl	181-184
	CF ₃	Cl	7-trifluoromethyl-4-quinolyl	156
10	CF ₃	CN	7-trifluoromethyl-4-quinolyl	156
	Cl	Cl	2-imidazolyl	141
	CF ₃	CN	2-imidazolyl	(oil)
	CF ₃	F	2-imidazolyl	(oil)
15	CF ₃	F	1-methyl-2-imidazolyl	(oil)
	Cl	Cl	1-methyl-2-imidazolyl	100
	CF ₃	CN	1-methyl-2-imidazolyl	108
	Cl	Cl	2-thiazolyl	(oil)
	CF ₃	F	2-thiazolyl	(oil)
20	CF ₃	CN	2-thiazolyl	(oil)
	Cl	F	2-thiazolyl	(oil)
	Cl	Cl	1,2,4-triazol-3-yl	72
	Cl	Cl	2-pyrimidinyl	94
	Cl	F	2-pyrimidinyl	(oil)
25	CF ₃	F	2-pyrimidinyl	(oil)
	CF ₃	CN	2-pyrimidinyl	(oil)
	Cl	Cl	4-methyl-2-pyrimidinyl	89
	CF ₃	CN	4-methyl-2-pyrimidinyl	(oil)
	Cl	Cl	4-hydroxy-2-pyrimidinyl	96
30	CF ₃	CN	4-hydroxy-2-pyrimidinyl	(oil)
	Cl	Cl	4-amino-2-pyrimidinyl	119
	CF ₃	CN	4-amino-2-pyrimidinyl	(oil)
	CF ₃	CN	4,6-dimethyl-2-pyrimidinyl	(oil)
35	Cl	Cl	purin-6-yl	146

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	R ³	R ⁴	R ¹⁰	m.p. (°C.)
	CF ₃	CN	purin-6-yl	110
5	CF ₃	CN	1H-pyrazolo[3,4-d]- pyrimidin-4-yl	208
	Cl	Cl	2-chloro-6-methoxy- acridin-9-yl	211
	Cl	Cl	2-amino-6-puriny1	162
10	Cl	Cl	4,6-dimercapto-1,3,5- triazin-2-yl	240 (decomp.)
	Cl	Cl	benzimidazolo[1,2-c]- quinazolin-6-yl	198
	CF ₃	CN	4-amino-2-pyrimidinyl	(oil)
15				

Example 4

Magnesium chloride (0.4 g.) was added to a solution of 4-(3,4-dichlorophenyl)-1,2-epoxy-2-trifluoromethylbut-trans-3-ene (Example 3; 0.25 g.) in diethyl ether (10 ml.) and the suspension was stirred at laboratory temperature for 4 days. Methanol (0.5 ml.) was added and the mixture was stirred for 2 days and then poured into water. The mixture was extracted with methylene chloride and the extract was washed with water and then with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using a 4:1 v/v mixture of petroleum ether (b.p. 60-80°C.) and methylene chloride as eluant. There was thus obtained 1-chloro-4-(3,4-dichlorophenyl)-2-trifluoromethylbut-trans-3-en-2-ol, m.p. 64°C.

Example 5

A mixture of 1-(3,4-dichlorophenyl)-4,4,4-trifluoro-3-trifluoromethylbutane-1,3-diol (10.0 g.) and p-toluenesulphonic acid (2.0 g.) was heated at 140°C.

for 15 minutes, cooled to laboratory temperature and partitioned between water and ethyl acetate. The ethyl acetate layer was washed with saturated aqueous sodium bicarbonate solution and then with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using a 9:1 v/v mixture of petroleum ether (b.p. 60-80°C.) and methylene chloride as eluant, and there was thus obtained as an oil 4-(3,4-dichlorophenyl)-1,1,1-trifluoro-2-trifluoromethylbut-trans-3-en-2-ol.

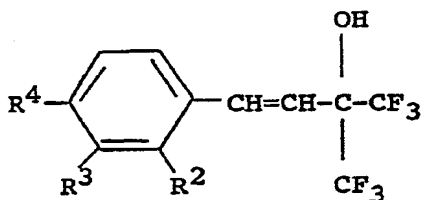
The butane-1,3-diol used as starting material was obtained as follows:-

A solution of 3,4-dichloroacetophenone (5.0g.) in tetrahydrofuran (50 ml.) was added dropwise to a stirred solution of lithium diisopropylamide (prepared from n-butyl-lithium [19.8 ml. of a 1.6 molar solution in hexane] and diisopropylamine (4.3 ml.) in tetrahydrofuran (200 ml.) during 10 minutes at 0°C.) which was cooled to -78°C., and the mixture was stirred at -78°C for 30 minutes and then at -50°C. for 45 minutes, and then recooled to -78°C. Anhydrous hexafluoroacetone (10 ml., generated by treating the sesquihydrate with concentrated sulphuric acid) was distilled into the mixture, which was then stirred for 1 hour at -78°C. Methanol (10 ml.) and saturated aqueous ammonium chloride solution (50 ml.) were added, the mixture was allowed to warm up to laboratory temperature and was poured into water (250 ml.) and the mixture was extracted with diethyl ether. The extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure, and there was thus obtained as an oil 1-(3,4-dichlorophenyl)-4,4,4-trifluoro-3-hydroxy-3-trifluoromethylbutan-1-one which was used without

further purification.

Sodium borohydride (3.2 g.) was added in portions during 15 minutes to a stirred solution of the total amount obtained of the above compound in ethanol (200 ml.) which was cooled to 0°C., and the mixture was stirred at 0°C. for 1 hour. Concentrated aqueous hydrochloric acid was added to neutralise the mixture, the ethanol was removed by evaporation under reduced pressure and the residue was partitioned between diethyl ether and water. The ethereal layer was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure, and there was thus obtained as residue 1-(3,4-dichlorophenyl)-4,4,4-trifluoro-3-trifluoro-methylbutane-1,3-diol which was used without further purification.

The process described above was repeated using the appropriate acetophenone as initial starting material and there were thus obtained the compounds described in the following table:-



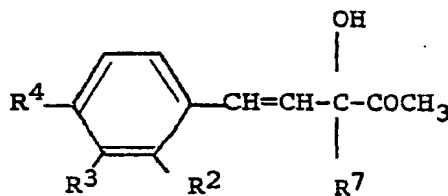
	R ²	R ³	R ⁴	m.p. (°C.)
	H	H	Cl	(oil)
	H	H	CN	115-117
	H	Cl	H	(oil)
35	Cl	H	Cl	(oil)

The process described above was repeated using 3,4-dichloropropiophenone in place of 3,4-dichloroacetophenone as initial starting material. There was thus obtained as an oil 4-(3,4-dichlorophenyl)-1,1,1-trifluoro-3-methyl-2-trifluoromethyl-but-trans-3-en-2-ol.

Example 6

A solution of 1-(3,4-dichlorophenyl)-3-trifluoromethylpent-trans-1-en-4-yn-3-ol (Example 2; 0.8 g.) in methanol (5 ml.) was added to a stirred solution of mercuric oxide (0.6 g.) in 4% w/v aqueous sulphuric acid (50 ml.) which was heated to 60°C., and the mixture was stirred at 60°C. for 30 minutes, cooled to laboratory temperature and extracted with ethyl acetate. The extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure, and the residue was purified by chromatography on a silica gel column using a 3:2 v/v mixture of methylene chloride and petroleum ether (b.p. 60-80°C.) as eluant. There was thus obtained as an oil 5-(3,4-dichlorophenyl)-3-hydroxy-3-trifluoromethylpent-trans-4-en-2-one.

The process described above was repeated using the appropriate pentenynol described in Example 2 or Example 8 as starting material, and there were thus obtained the compounds described in the following table:-



	R ²	R ³	R ⁴	R ⁷	m.p. (°C.)
	H	H	CN	CF ₃	(oil)
5	H	CN	H	CF ₃	88-89
	H	Cl	F	CF ₃	(oil)
	F	H	F	CF ₃	(oil)
	H	Cl	CN	CF ₃	104-105
	H	CF ₃	H	CF ₃	61-63
10	H	F	CN	CF ₃	75.5-76.5
	H	CN	Cl	CF ₃	(oil)
	H	CF ₃	F	CF ₃	(oil)
	H	CF ₃	Cl	CF ₃	(oil)
	H	CF ₃	NO ₂	CF ₃	94-95
15	H	CF ₃	CN	CF ₃	96
	H	CF ₃	CN	CH ₃	(oil)
	H	Cl	Cl	CH ₂ Cl	(oil)
	(4,5-dichlorothien-2-yl)			CF ₃	(oil)*
20	(6-chloropyrid-3-yl)			CF ₃	(oil)*

* The 2-R²-3-R³-4-R⁴-phenyl group is replaced by the named heterocyclyl group.

25 Example 7

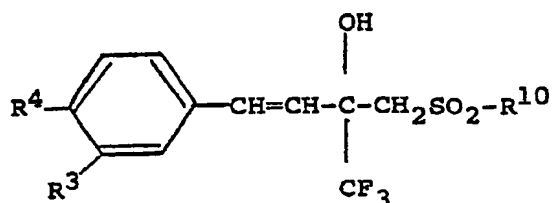
A solution of potassium peroxymonosulphate (1.9 g.) in water (14 ml.) was added to a stirred solution of 4-(3,4-dichlorophenyl)-1-(pyrid-2-ylthio)-2-trifluoromethylbut-trans-3-en-2-ol (Example 3; 0.4 g.)

30 in methanol (14 ml.) and the mixture was stirred at laboratory temperature for 16 hours, diluted with water (20 ml.) and extracted with ethyl acetate. The extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated

35 to dryness under reduced pressure, and the residue was

purified by chromatography on a silica gel column using a 7:3 v/v mixture of petroleum ether (b.p. 60-80°C.) and ethyl acetate as eluant. There was thus obtained as a gum 4-(3,4-dichlorophenyl)-1-(pyrid-2-ylsulphonyl)-2-trifluoromethylbut-trans-3-en-2-ol.

The process described above was repeated using the appropriate thio-compound described in Example 3 as starting material, and there were thus obtained the compounds described in the following table:-



	R ³	R ⁴	R ¹⁰	m.p. (°C.)
	Cl	Cl	ethyl	88
	Cl	Cl	n-propyl	102
	Cl	Cl	allyl	87
25	Cl	Cl	4-fluorophenyl	165
	H	CN	4-fluorophenyl	(oil)
	Cl	Cl	4-chlorophenyl	133
	Cl	Cl	4-nitrophenyl	201
	H	CN	2-pyridyl	(oil)
30	Cl	Cl	2-thiazolyl	81
	Cl	F	2-thiazolyl	(oil)
	Cl	Cl	3-methylsulphonyl-phenyl	88
	Cl	CN	3-methylsulphonyl-phenyl	95
35				

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	R ³	R ⁴	R ¹⁰	m.p. (°C.)
	Cl	CN	4-methylsulphonyl-phenyl	172
5	Cl	Cl	7-trifluoromethyl-quinol-4-yl	187
	Cl	Cl	2-chloro-6-methoxy-acridin-9-yl	262
10	Cl	Cl	pyrid-4-yl*	161
	Cl	F	pyrid-4-yl*	148

* Under the conditions described above the oxidation stopped at the sulfoxide stage and these two compounds have the group -CH₂SOR¹⁰ in place of -CH₂SO₂R¹⁰

Example 8

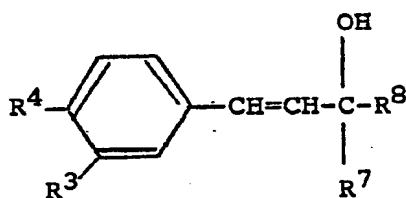
A solution of s-butyllithium (8.6 ml. of a 1.3 molar solution in cyclohexane) was added dropwise to a stirred suspension of methyltriphenylphosphonium bromide (2.0 g.) in tetrahydrofuran (20 ml.) which was cooled to -78°C. under an atmosphere of argon, and the mixture was stirred at -78°C. for 1 hour, at laboratory temperature for 3 hours and was then recooled to -78°C.

Trifluoroacetone (0.5 ml.) was added dropwise, the mixture was stirred for 15 minutes, n-butyllithium (3.8 ml. of a 1.6 molar solution in hexane) was added dropwise and the mixture was stirred for a further 15 minutes still at -78°C. A solution of 3-chloro-4-cyanobenzaldehyde (0.95 g.) in tetrahydrofuran (12 ml.) was added dropwise and the mixture was stirred for 10 minutes at -78°C., 2 hours at 0°C. and 12 hours at laboratory temperature. Saturated aqueous sodium chloride solution (20 ml.) was added, the layers were separated and the aqueous layer was extracted twice with

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diethyl ether (25 ml. each time). The combined organic solutions were dried and evaporated to dryness and the residual oil was purified by flash chromatography on a silica gel column using a 3:1 v/v mixture of petroleum ether (b.p. 60-80°C.) and ethyl acetate as eluant. The product obtained was crystallised from a 1:1 v/v mixture of toluene and petroleum ether (b.p. 60-80°C.) and there was thus obtained 4-(3-chloro-4-cyanophenyl)-2-trifluoromethylbut-trans-3-en-2-ol, m.p. 88-92°C.

The process described above was repeated using the appropriate aldehyde in place of 3-chloro-4-cyanobenzaldehyde, and the appropriate ketone of the formula R^7COR^8 in place of trifluoroacetone, as starting materials, and there were thus obtained the compounds described in the following table:-



	R^3	R^4	R^7	R^8	m.p. (°C.)	Note
25	Cl	NO_2	CF_3	CH_3	(oil)	
	CF_3	NO_2	CF_3	CH_3	67-69	
	CF_3	Cl	CF_3	CH_3	(oil)	
	CF_3	CN	CF_3	CH_3	112-115	
30	CH_3S	CN	CF_3	CH_3	113-115	
	CH_3SO	CN	CF_3	CH_3	115-120	1
	CH_3SO_2	CN	CF_3	CH_3	107-108	2
	CH_3O	CN	CF_3	CH_3	104-106	
	(5-cyanothien-2-yl)		CF_3	CH_3	(oil)	3
35	(5-nitrothien-2-yl)		CF_3	CH_3	(oil)	3

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	R ³	R ⁴	R ⁷	R ⁸	m.p. (°C.)	Note
	(2-chloropyrid-4-yl)		CF ₃	CH ₃	(oil)	3
5	(6-chloropyrid-3-yl)		CF ₃	CH ₃	(oil)	3
	Cl	Cl	CF ₃	C ₂ H ₅	(oil)	
	CF ₃	Cl	CF ₃	C ₂ H ₅	(oil)	
	CN	H	CF ₃	C ₂ H ₅	83-85	
	H	CN	CF ₃	C ₂ H ₅	(oil)	
10	CH ₃	CN	CF ₃	C ₂ H ₅	87-88	
	F	CN	CF ₃	C ₂ H ₅	(oil)	
	Cl	CN	CF ₃	C ₂ H ₅	106	
	Br	CN	CF ₃	C ₂ H ₅	(oil)	
	CF ₃	CN	CF ₃	C ₂ H ₅	120-121	
15	CF ₃	CN	CF ₃	n-propyl	139-140	
	CF ₃	CN	CF ₃	isopropyl	99-101	
	CF ₃	CN	CF ₃	n-butyl	100-102	
	CF ₃	CN	CF ₃	n-hexyl	84	
	CF ₃	CN	CF ₃	cyclopropyl	119-120	
20	CF ₃	CN	CF ₃	CH ₂ CH ₂ C ₆ H ₅	116-118	
	CF ₃	CN	CF ₃	ethynyl	121-123	4
	Cl	CN	CF ₃	ethynyl	116-117	4
	CH ₃ O	CN	CF ₃	ethynyl	100-101	4
	Cl	NO ₂	CF ₃	ethynyl	(oil)	4
25	F	CN	CF ₃	ethynyl	92-94	4
	CF ₃	CN	C ₂ F ₅	CH ₃	106-107	
	CF ₃	CN	methyl	C ₂ H ₅	(oil)	
	Cl	F	CF ₃	isopropyl	(oil)	

30

Note 1 Prepared by oxidation of the corresponding compound wherein R³ is CH₃S(immediately preceding compound in table) with sodium metaperiodate by a similar process to that described in Example 5 of European Specification No. 100172.

35

Note 2 Prepared by oxidation of the corresponding compound wherein R^3 is CH_3S with m-chloroperbenzoic acid by a similar process to that described in Example 6 of European Specification No. 100172.

5 Note 3 The 3- R^3 -4- R^4 -phenyl group is replaced by the named heterocyclic group.

Note 4 The ketone starting material used was trifluoromethyl 2-trimethylsilylethynyl ketone (b.p. 110-115°C.), the trimethylsilyl group being removed as
10 described in Note 5 to Example 2.

The ketones used as starting materials were prepared by the general process described in the Journal of the Chemical Society, 1956, page 835. Cyclopentyl trifluoromethyl ketone has b.p. 118-120°C.

15 Example 9

The process described in Example 3 was repeated except that the pyridine-2-thiol and sodium hydride were replaced by either dimethyl sulphone and *n*-butyl-lithium (as in Example 1), or by acetonitrile
20 and lithium diisopropylamide. There were thus obtained respectively 5-(3,4-dichlorophenyl)-1-methylsulphonyl-3-trifluoromethylpent-trans-4-en-3-ol, m.p 71°C. and 5-(3,4-dichlorophenyl-1-cyano-3-trifluoromethylpent-trans-4-en-3-ol, m.p 68°C.

25 Example 10

The process described in Example 3 was repeated except that acetamide was used as starting material in place of pyridine-2-thiol. The product was purified by chromatography on a silica gel column using
30 a 3:2 v/v mixture of petroleum ether (b.p. 60-80°C.) and ethyl acetate as eluant, and there was thus obtained N-[4-(3,4-dichlorophenyl)-2-hydroxy-2-trifluoromethyl-but-trans-3-enyl]acetamide, m.p. 94°C.

Example 11

35 The process described in Example 3 was repeated except that concentrated aqueous ammonia solution was used in place of the mixture of

pyridine-2-thiol and sodium hydride. There was thus obtained 1-amino-4-(3,4-dichlorophenyl)-2-trifluoromethylbut-trans-3-en-2-ol, m.p. 96°C.

Example 12

5 Pyridine (0.053 g.) and methanesulphonyl chloride (0.05 ml.) were successively added to a stirred solution of 1-amino-4-(3,4-dichlorophenyl)-2-trifluoromethylbut-trans-3-en-2-ol (Example 11; 0.2 g.) in methylene chloride (2 ml.) and the mixture was stirred
10 at laboratory temperature for 30 minutes and then evaporated to dryness. The residue was purified by chromatography on a silica gel column using a 3:2 v/v mixture of petroleum ether (b.p. 60-80°C.) and ethyl acetate as eluant, and there was thus obtained
15 N-[4-(3,4-dichlorophenyl)-2-hydroxy-2-trifluoromethylbut-trans-3-enyl]methanesulphonamide, m.p. 151°C.

 The process described above was repeated using methyl chloroformate in place of methanesulphonyl chloride. There was thus obtained methyl
20 N-[4-(3,4-dichlorophenyl)-2-hydroxy-2-trifluoromethylbut-3-enyl]carbamate, m.p. 132°C.

Example 13

 A mixture of 4-(3,4-dichlorophenyl)-1-methylsulphanyl-1-methylthio-2-trifluoromethylbut-trans-3-en-2-ol (Example 2; 0.3 g.), triethyl orthoformate
25 (1.12 g.), ethanol (5 ml.) and concentrated sulphuric acid (0.01 ml.) was heated under reflux for 4 hours, cooled to laboratory temperature and poured into water (20 ml.) The mixture was extracted with ethyl acetate
30 (20 ml.) and the extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was dissolved in tetrahydrofuran (5 ml.), 60% aqueous sulphuric acid (1 ml.) was added
35 and the solution was freed from air and then heated

under reflux under an atmosphere of argon for 1 hour. Water (15 ml.) was added, the mixture was extracted with ethyl acetate, and the extract was washed with water and then with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using a 3:2 v/v mixture of methylene chloride and petroleum ether (b.p. 60-80°C.) as eluant. There was thus obtained as an oil 4-(3,4-dichlorophenyl)-2-hydroxy-2-trifluoromethylbut-trans-3-en-1-one.

The process described above was repeated using 6-(3,4-dichlorophenyl)-3-methylsulphinyl-3-methylthio-4-trifluoro-methylhex-trans-5-en-4-ol (Example 2) as starting material, and there was thus obtained as an oil 6-(3,4-dichlorophenyl)-4-hydroxy-4-trifluoromethylhex-trans-5-en-3-one.

Example 14

A solution of 4-(3,4-dichlorophenyl)-2-hydroxy-2-trifluoromethylbut-trans-3-en-1-one (Example 13; 0.8 g.) in ethanol (5 ml.) was added dropwise to a stirred solution of sodium borohydride (0.3 g.) in ethanol (5 ml.), and the mixture was stirred at laboratory temperature for 2 hours, acidified with aqueous 2N-hydrochloric acid (1 ml.) and poured into water (20 ml.). The mixture was extracted with ethyl acetate and the extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using a 40:1 v/v mixture of methylene chloride and ethyl acetate as eluant. There was thus obtained 4-(3,4-dichlorophenyl)-2-trifluoromethylbut-trans-3-ene-1,2-diol, m.p. 162°C.

The process described above was repeated using

either 5-(3,4-dichlorophenyl)-3-hydroxy-3-trifluoromethylpent-trans-4-en-2-one (Example 6) or 6-(3,4-dichlorophenyl)-4-hydroxy-4-trifluoromethylhex-trans-5-en-3-one (Example 13) as starting materials, and there were respectively obtained 5-(3,4-dichlorophenyl)-3-trifluoromethylpent-trans-4-ene-2,3-diol, m.p.65°C. and 6-(3,4-dichlorophenyl)-4-trifluoromethylhex-trans-5-ene-3,4-diol, as an oil.

Example 15

A complex of potassium cyanide and 18-crown-6- (0.002 g.) was added to a stirred solution of 1,1,1-trifluoro-4-(3,4-dichlorophenyl)but-trans-3-en-2-one (Example 1; 1 g.) in trimethylsilyl cyanide (0.79 g.) and the mixture was stirred at laboratory temperature for 1 hour and then evaporated to dryness under reduced pressure. A solution of the residue in tetrahydrofuran (2 ml.) was added to a saturated solution of hydrogen chloride in methanol (50 ml.) and the mixture was stirred at laboratory temperature for 17 hours and then poured into ice-water. The mixture was extracted with ethyl acetate and the extract was washed with water and then with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using a 20:3 v/v mixture of methylene chloride and ethyl acetate as eluant. There was thus obtained 4-(3,4-dichlorophenyl)-2-hydroxy-2-trifluoromethylbut-trans-3-enamide, m.p.149°C.

Example 16

Acetic anhydride (0.2 g.) and pyridine (0.15 g.) were successively added to a stirred solution of 4-(3,4-dichlorophenyl)-2-hydroxy-2-trifluoromethylbut-trans-3-enoic acid (0.2 g.) in ethyl acetate (5 ml.) and the mixture was stirred at laboratory

temperature for 17 hours and then evaporated to dryness under reduced pressure. The residue was dissolved in methylene chloride (5 ml.), pyridine (0.1 g.) and thionyl chloride (0.15 g.) were added and the mixture was stirred at laboratory temperature for 1 hour. Monomethylamine gas was then passed through the mixture until it was saturated, and the mixture was stirred at laboratory temperature for 1 hour and then poured into water. The mixture was extracted with methylene chloride and the extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. Aqueous 2N-sodium hydroxide solution (0.2 ml.) was added to a stirred solution of the residue in ethanol (5 ml.) and the mixture was stirred at laboratory temperature for 90 minutes, diluted with water and extracted with ethyl acetate. The extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using a 20:1 v/v mixture of methylene chloride and ethyl acetate as eluant. There was thus obtained 4-(3,4-dichlorophenyl)-2-hydroxy-N-methyl-2-trifluoromethylbut-trans-3-enamide, m.p. 165°C.

The process described above was repeated using dimethylamine in place of monomethylamine, and there was thus obtained 4-(3,4-dichlorophenyl)-2-hydroxy-N,N-dimethyl-2-trifluoromethylbut-trans-3-enamide, m.p. 168°C.

The 4-(3,4-dichlorophenyl)-2-hydroxy-2-trifluoromethylbut-trans-3-enoic acid used as starting material was obtained as follows:-

Concentrated sulphuric acid (1 ml.) was added to a solution of 4-(3,4-dichlorophenyl)-2-hydroxy-2-trifluoromethylbut-trans-3-enamide (Example 15; 0.3 g.)

in ethanol (20 ml.) and the mixture was heated under reflux for 24 hours, diluted with water and extracted with ethyl acetate. The extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. Aqueous 2N-sodium hydroxide solution (0.7 ml.) was added to a stirred solution of the residue in ethanol (10 ml.) and the mixture was stirred at laboratory temperature for 17 hours and then poured into water. The mixture was washed with ethyl acetate and the aqueous layer was then acidified with aqueous 2N-hydrochloric acid and extracted with ethyl acetate. The extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. There was thus obtained as residual solid 4-(3,4-dichlorophenyl)-2-hydroxy-2-trifluoromethylbut-trans-3-enoic acid which was used without further purification.

Example 17

t-Butyl-lithium (1.1 ml. of a 1.8 molar solution in diethyl ether) was added dropwise to a solution of trans-1-bromo-2-(3,4-dichlorophenyl)cyclopropane (0.53 g.) in a mixture of diethyl ether (18 ml.) and tetrahydrofuran (2 ml.) which was maintained at -100°C., and the mixture was stirred at that temperature for 1 hour. A solution of 1,1,1-trifluoro-4-trimethylsilylbut-3-yn-2-one (0.39 g.) in tetrahydrofuran (5 ml.) was added dropwise, the mixture was stirred at -100°C. for 2 hours and a mixture of methanol (1 ml.) and aqueous 2N-hydrochloric acid (1 ml.) was added. The mixture was allowed to warm up to laboratory temperature and was poured into water, and the mixture was extracted with ethyl acetate. The extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under

reduced pressure. Tetra-n-butylammonium fluoride (0.16 g.) was added to a stirred solution of the residue in tetrahydrofuran (25 ml.) and the mixture was stirred at laboratory temperature for 4 hours, diluted with water (100 ml.) and extracted with ethyl acetate. The extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using an 11:9 v/v mixture of petroleum ether (b.p. 60-80°C.) and methylene chloride as eluant. There was thus obtained as an oil 2-[2-(3,4-dichlorophenyl)-cyclopropyl]-1,1,1-trifluorobut-3-yn-2-ol.

The cyclopropane used as starting material was obtained as follows:-

Potassium t-butoxide (5.1 g.) was added to a stirred mixture of 3,4-dichlorophenylethylene (6.1 g.), bromoform (8.9 g.) and petroleum ether (b.p. 60-80°C; 100 ml.) which was cooled to -30°C., and the mixture was stirred at that temperature for 30 minutes, then at laboratory temperature for 17 hours and then poured into water. The mixture was extracted with ethyl acetate and the extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using petroleum ether (b.p. 40-60°C.) as eluant, and there was thus obtained as an oil 1,1-dibromo-2-(3,4-dichlorophenyl)cyclopropane.

n-Butyl-lithium (14.7 ml. of a 1.6 molar solution in hexane) was added dropwise to a stirred solution of the above cyclopropane (8.1 g.) in tetrahydrofuran (100 ml.) which was maintained at -100°C., and the mixture was stirred at that temperature for 30 minutes. A mixture of methanol (2.5 ml.) and

aqueous 2N-hydrochloric acid (2.5 ml.) was added and the mixture was allowed to warm up to laboratory temperature and was then poured into water. The mixture was extracted with ethyl acetate and the extract was washed with saturated aqueous sodium chloride solution, dried over magnesium sulphate and evaporated to dryness under reduced pressure. The residue was purified by chromatography on a silica gel column using petroleum ether (b.p. 40-60°C.) as eluant. There was thus obtained as an oil trans-1-bromo-2-(3,4-dichlorophenyl)-cyclopropane, which was used without further purification.

Example 18

A mixture of 4-iodo-2-trifluoromethylbenzonitrile (1.65 g.), bis-(triphenylphosphine)palladium (II) chloride (0.07 g.), cuprous iodide (0.01 g.), 1-methylsulphonyl-2-trifluoromethylbut-3-yn-2-ol (1.2 g.) and diethylamine (25 ml.) was stirred at laboratory temperature under an atmosphere of argon for 4 hours and then evaporated to dryness. The residue was purified by flash chromatography on a silica gel (Merck 9385) column using a 1:1 v/v mixture of ethyl acetate and petroleum ether (b.p. 60-80°C.) as eluant, and the product was crystallised from a 4:1 v/v mixture of petroleum ether (b.p. 60-80°C.) and ethyl acetate. There was thus obtained 4-(4-cyano-3-trifluoromethylphenyl)-1-methylsulphonyl-2-trifluoromethylbut-3-yn-2-ol, m.p. 134-136°C.

The 1-methylsulphonyl-2-trifluoromethylbut-3-yn-2-ol used as starting material was obtained as follows:-

n-Butyl-lithium (10.6 ml. of a 1.6 molar solution in hexane) was added dropwise to a solution of dimethyl sulphone (1.6 g.) in tetrahydrofuran (50 ml.) which was maintained at -20°C. under an atmosphere of

argon, and the mixture was stirred at that temperature for 1 hour and then cooled to -78°C . A solution of 1,1,1-trifluoro-4-trimethylsilylbut-3-yn-2-one (3.0 g.) in tetrahydrofuran (10 ml.) was added dropwise and the mixture was stirred at -78°C . for 90 minutes. Water (0.5 ml.) was added and the mixture was allowed to warm up to laboratory temperature and was then evaporated to dryness under reduced pressure. The residue was purified by flash chromatography on a silica gel (Merck 9385) column using a 1:1 v/v mixture of ethyl acetate and petroleum ether (b.p. $60-80^{\circ}\text{C}$.) as eluant. There was thus obtained 1-methylsulphonyl-2-trifluoromethyl-4-trimethylsilylbut-3-yn-2-ol, m.p. $61-64^{\circ}\text{C}$.

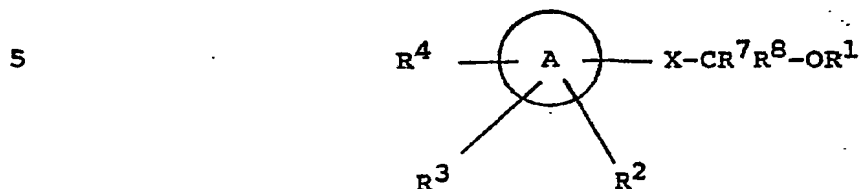
A solution of potassium hydroxide (0.5 g.) in water (0.5 ml.) was added to a stirred solution of the above compound (1.5 g.) in methanol (10 ml.) and the mixture was stirred at laboratory temperature for 10 minutes and evaporated to dryness. The residue was subject to flash chromatography on a silica gel (Merck 9385) column using a 1:1 v/v mixture of ethyl acetate and petroleum ether (b.p. $60-80^{\circ}\text{C}$.) as eluant. The product was crystallised from toluene and there was thus obtained 1-methylsulphonyl-2-trifluoromethylbut-3-yn-2-ol, m.p. $89-91^{\circ}\text{C}$.

Example 19

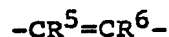
A solution of 4-(4-cyano-3-trifluoromethylsulphonyl-2-trifluoromethylbut-3-yn-2-ol (Example 18; 0.5 g.) and potassium hydroxide (0.015 g.) in methanol (20 ml.) was shaken with a 5% palladium-on-charcoal catalyst (0.025 g.) in an atmosphere of hydrogen at laboratory temperature until uptake of hydrogen ceased. The mixture was filtered, the filtrate was evaporated to dryness and the residue was crystallised from toluene. There was thus obtained 4-(4-cyano-3-trifluoromethylphenyl)-1-methylsulphonyl-2-trifluoromethylbut-cis-3-en-2-ol, m.p. $124-125^{\circ}\text{C}$.

What we claim is:-

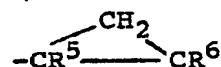
1. A compound of the formula



10 wherein X has the formula



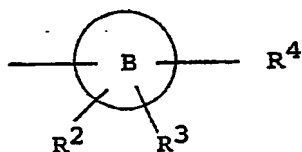
15 or



wherein ring A is phenyl, naphthyl or heterocyclic;
 wherein R^1 is hydrogen, alkyl or alkanoyl each of up to
 6 carbon atoms or aroyl of up to 10 carbon atoms;
 20 wherein R^2 , R^3 and R^4 , which may be the same or
 different, each is an electron withdrawing substituent
 selected from halogeno, nitro, cyano and
 trifluoromethyl, and alkylthio, alkylsulphinyl and
 alkylsulphonyl each of up to 6 carbon atoms, or each is
 25 hydrogen or alkyl, alkoxy or dialkylamino each of up to
 6 carbon atoms, provided that when ring A is phenyl or
 naphthyl at least one of R^2 , R^3 and R^4 is an
 electron-withdrawing substituent;
 wherein R^5 and R^6 , which may be the same or different,
 30 each is hydrogen, halogeno or alkyl of up to 6 carbon
 atoms, ;
 wherein R^7 is alkyl or halogenoalkyl each of up to 6
 carbon atoms;
 and wherein R^8 is carbamoyl, alkyl, cycloalkyl, alkenyl,
 35 alkynyl, halogenoalkyl, halogenoalkenyl, halogenoalkynyl

or alkanoyl each of up to 6 carbon atoms, or alkyl-carbamoyl or dialkylcarbamoyl wherein each alkyl is of up to 6 carbon atoms, or aroyl of up to 10 carbon atoms;

5. or wherein R^8 is alkyl or alkenyl each of up to 6 carbon atoms which bears one or more substituents selected from cyano, carbamoyl, amino and hydroxy, alkanoyl, alkoxy, alkylthio, alkenylthio, alkylsulphinyl, alkenylsulphinyl, alkylsulphonyl, alkenylsulphonyl, alkanoylamino, alkoxy-carbonylamino and alkylsulphonamido each of up to 6 carbon atoms, alkylamino, dialkylamino and dialkylsulphamoyl wherein each alkyl is of up to 6 carbon atoms, aroyl, aryl, arylthio, arylsulphinyl and arylsulphonyl each of up to 10 carbon atoms and
10 heterocyclylthio, heterocyclylsulphinyl and heterocyclylsulphonyl;
15 or wherein R^8 has the formula



20 wherein ring B is phenyl, naphthyl or heterocyclyl and wherein R^2 , R^3 and R^4 have any of the meanings stated above, provided that when R^7 is methyl R^8 is not also methyl.

2. A compound of the formula stated in claim 1 wherein X is $-CR^5=CR^6-$, wherein ring A is phenyl, wherein one or two (the same or different) of R^2 , R^3 and R^4 are fluoro, chloro, cyano, trifluoromethyl or nitro, the others of R^2 , R^3 and R^4 being hydrogen, wherein R^1 , R^5 and R^6 are all hydrogen, wherein R^7 is trifluoromethyl, pentafluoroethyl, heptafluoropropyl, chloromethyl or dichloromethyl, wherein R^8 is methyl,
30 ethyl, n-propyl, isopropyl, n-butyl, cyclopropyl,

cyclopentyl, trifluoromethyl, chloromethyl, dichloromethyl, ethynyl, chloroethynyl, acetyl or propionyl or is methylene ($-\text{CH}_2-$) substituted by cyano, hydroxy, carbamoyl, formyl, acetyl, alkylthio, alkenylthio, alkylsulphonyl or alkenylsulphenyl each of up to 6 carbon atoms, phenylthio or phenylsulphonyl which itself is unsubstituted or bears a fluoro, chloro, nitro, carbamoyl, acetamido, methylthio or methylsulphonyl substituent, pyridyl, quinolyl, pyrimidinyl, purinyl, pyrazolopyrimidinyl, thiazolyl, imidazolyl or triazolyl any of which is unsubstituted or bears a hydroxy, mercapto, amino, chloro, trifluoromethyl or methyl substituent, and wherein the $-\text{CR}^5=\text{CR}^6-$ group is in the trans- configuration.

3. A compound of the formula stated in claim 1 wherein X is trans- $-\text{CH}=\text{CH}-$, wherein ring A is 3,4-dichlorophenyl, 3-chloro-4-cyanophenyl, 3-chloro-4-fluorophenyl, 4-chloro-3-trifluoromethylphenyl, 4-cyanophenyl, 4-cyano-3-fluorophenyl, 4-cyano-3-trifluoromethylphenyl or 4-fluoro-3-trifluoromethylphenyl, wherein R^1 is hydrogen, wherein R^7 is trifluoromethyl and wherein R^8 is ethyl, ethynyl, cyanomethyl, 1-cyanoethyl, acetyl, methylsulphonylmethyl, p-methylsulphonylphenylsulphonylmethyl or pyrid-2-ylsulphonyl, or has the formula $-\text{CH}_2\text{SR}^9$ wherein R^9 is m-methylthiophenyl, pyrid-4-yl, pyrimid-2-yl, 4,6-dimethylpyrimid-2-yl, purin-6-yl, 1H-pyrazolo[3,4-d]pyrimidin-4-yl, imidazol-2-yl, 1-methylimidazol-2-yl, 7-chloroquinolin-4-yl or 7-trifluoromethylquinolin-4-yl.

4. A compound selected from 5-(3,4-dichlorophenyl)-3-hydroxy-3-trifluoromethylpent-trans-4-en-2-one;

5-(3,4-dichlorophenyl)- and 5-(4-cyano-3-trifluoromethylphenyl)-3-trifluoromethylpent-trans-4-en-1-yn-3-ol;

5-(4-cyanophenyl)- and 5-(4-cyano-3-trifluoromethylphenyl)-3-hydroxy-3-trifluoromethylpent-trans-4-enenitrile;

4-(3-chloro-4-fluorophenyl-, 4-cyanophenyl-, 4-cyano-3-trifluoromethylphenyl-, 4-chloro-3-trifluoromethylphenyl and 4-fluoro-3-trifluoromethylphenyl)-1-methylsulphonyl-2-trifluoromethylbut-trans-3-en-2-ol;

5-(3,4-dichlorophenyl)-3-hydroxy-2-methyl-3-trifluoromethylpent-trans-4-enenitrile;

4-(3,4-dichlorophenyl)-1-(pyrid-4-ylthio)-2-trifluoromethylbut-trans-3-en-2-ol;

4-(3,4-dichlorophenyl)-1-(pyrimidin-2-ylthio)-2-trifluoromethylbut-trans-3-en-2-ol; and

4-(3,4-dichlorophenyl)-1-(pyrid-2-ylsulphonyl)-2-trifluoromethylbut-trans-3-en-2-ol.

5. A compound selected from 4-(4-cyano-3-trifluoromethylphenyl)-1-(7-chloroquinolin-4-ylthio)-, 1-(7-trifluoromethylquinolin-4-ylthio)-, 1-(pyrimidin-2-ylthio)-, 1-(4,6-dimethylpyrimidin-2-ylthio)-, 1-(purin-6-ylthio)-, 1-(1H-pyrazolo[3,4-d]pyrimidin-4-ylthio)-1-(imidazol-2-ylthio)- and 1-(1-methylimidazol-2-ylthio)-2-trifluoromethylbut-trans-3-en-2-ol;

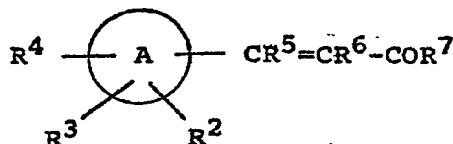
5-(3,4-dichlorophenyl)- and 5-(4-cyano-3-trifluoromethylphenyl)-3-trifluoromethylpent-trans-3-en-2-ol; 4-(3-chloro-4-cyanophenyl)-1-(m-methylthiophenyl)thio-2-trifluoromethylbut-trans-3-en-2-ol; and 4-(3-chloro-4-cyanophenyl)-1-(p-methylsulphonylphenylsulphonyl)-2-trifluoromethylbut-trans-3-en-2-ol.

6. A process for the manufacture of a compound claimed in any of claims 1 to 5 which comprises:-

(a) for the manufacture of an alkene wherein R¹ is hydroxy and X is -CR⁵=CR⁶-, the reaction of a compound of the formula:

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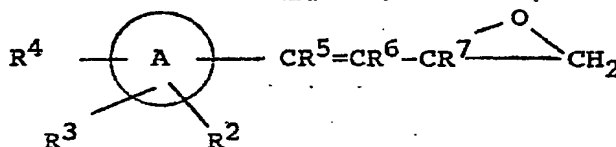


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wherein A, R², R³, R⁴, R⁵, R⁶ and R⁷ have the meanings stated in claim 1, with an organometallic compound of the formula R⁸-M, wherein R⁸ has the meaning stated in claim 1 and M is a metallic group; or

(b) for the manufacture of an alkene wherein R¹ is hydroxy, X is -CR⁵=CR⁶-, and R⁸ has the formula -CH₂R⁹, the reaction of an epoxide of the formula:

15



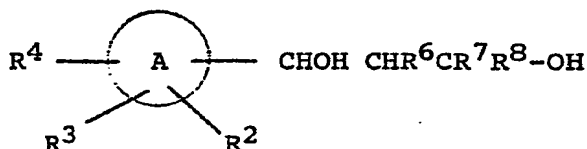
20

wherein A, R², R³, R⁴, R⁵, R⁶ and R⁷ have the meanings stated above, with a compound of the formula R⁹-H, wherein R⁹ is such that -CH₂R⁹ has the meaning stated above for R⁸; or

25

(c) for the manufacture of an alkene wherein R¹ and R⁵ are both hydrogen and X is -CH=CR⁶-, the dehydration of a compound of the formula

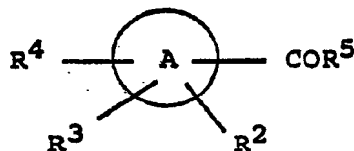
30



wherein A, R², R³, R⁴, R⁶, R⁷ and R⁸ have the meanings stated above; or

35

(d) for the manufacture of an alkene wherein R¹ is hydroxy and X is -CR⁵=CR⁶-, the reaction of a compound of the formula

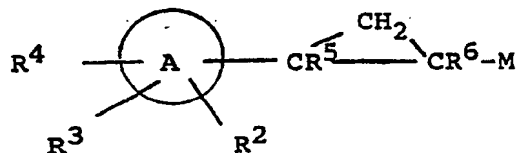


wherein A, R², R³, R⁴ and R⁵ have the meanings stated above, with a compound of the formula



wherein R⁷ and R⁸ have the meanings stated above; or
(e) for the manufacture of a cycloalkylene

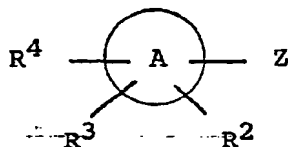
derivative wherein X is $-CR^5-\overset{CH_2}{\diagup}\diagdown-CHR^6$, the reaction of
a compound of the formula



wherein A, R², R³, R⁴, R⁵, R⁶ and M have the meanings stated above, with a compound of the formula



wherein R⁷ and R⁸ have the meanings stated above; or
(f) for the manufacture of an alkyne wherein X is $-C\equiv C-$, the reaction of a compound of the formula



wherein A, R¹, R², R³ and R⁴ have the meanings stated

above and wherein Z is a displaceable group, with a compound of the formula



5

wherein R^1 , R^7 and R^8 have the meanings stated above;

whereafter a compound wherein X is $-\text{C}\equiv\text{C}-$ may be reduced to the corresponding compound wherein X is $-\text{CH}=\text{CH}-$; and whereafter

- 10 (i) a compound wherein R^8 bears an amino substituent may be acylated to give the corresponding compound wherein R^8 bears an alkanoylamino, alkoxycarbonylamino, or alkylsulphonamido substituent;
- (ii) a compound wherein R^8 is alkyl containing an
15 alkylthio and an alkylsulphinyl substituent on the same carbon atom may be converted to the corresponding compound wherein said carbon atom is a carbonyl group;
- (iii) a compound wherein R^8 is alkanoyl or is alkyl
20 substituted by alkanoyl may be reduced to the corresponding compound wherein R^8 is hydroxyalkyl; or
- (iv) a compound wherein R^8 is alkynyl may be converted to the corresponding compound wherein R^8 is alkanoyl by hydration by conventional means;
- (v) a compound wherein R^1 is alkyl may be prepared
25 by the alkylation of the corresponding compound wherein R^1 is hydrogen;
- (vi) a compound wherein R^1 is alkanoyl or aroyl may be prepared by the acylation of the corresponding compound wherein R^1 is hydrogen; or
- 30 a compound wherein one or more of R^2 , R^3 , R^4 and a substituent in R^8 is alkyl-sulphinyl or alkylsulphonyl, or a substituent in R^8 is alkenylsulphinyl, arylsulphinyl, alkenylsulphonyl, arylsulphonyl, heterocyclylsulphinyl or heterocyclyl-

sulphonyl, may be prepared by the oxidation of the corresponding compound wherein one or more of R², R³, R⁴ and a substituent in R⁸ is alkylthio, alkenylthio, arylthio or heterocyclylthio, respectively.

5 7. A pharmaceutical or veterinary composition which comprises a compound claimed in any of claims 1 to 5 in association with a pharmaceutically-acceptable diluent or carrier.

10 8. A composition as claimed in claim 7 which is in a form suitable for oral dosage, as a tablet, capsule, aqueous or oily solution or suspension, or emulsion, or in the form of a sterile solution or suspension suitable for parenteral administration, or in the form of an ointment or lotion for topical administration, or in the form of a suppository.

15 9. A composition as claimed in claim 7 or 8 which additionally contains one or more drugs selected from anti-oestrogens, aromatase inhibitors, progestins, inhibitors of gonadotrophin secretion, LH-RH analogues, 20 cytotoxic agents, antibiotics and anti-inflammatory agents.

25 10. The use of a compound, claimed in any of claims 1 to 5, for the manufacture of a medicament for producing an antiandrogenic effect in a warm-blooded animal.

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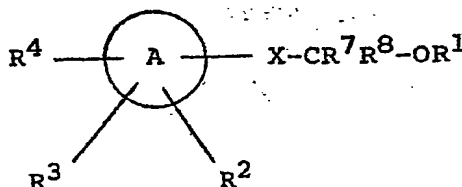
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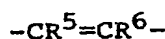
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What we claim is:-

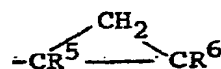
1. A process for the manufacture of a compound of the formula



- 10 wherein X has the formula



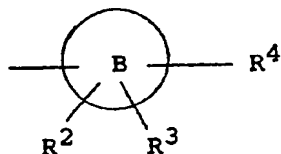
- 15 or



- wherein ring A is phenyl, naphthyl or heterocyclic;
 wherein R^1 is hydrogen, alkyl or alkanoyl each of up to 6 carbon atoms or aroyl of up to 10 carbon atoms;
 20 wherein R^2 , R^3 and R^4 , which may be the same or different, each is an electron withdrawing substituent selected from halogeno, nitro, cyano and trifluoromethyl, and alkylthio, alkylsulphinyl and alkylsulphonyl each of up to 6 carbon atoms, or each is
 25 hydrogen or alkyl, alkoxy or dialkylamino each of up to 6 carbon atoms, provided that when ring A is phenyl or naphthyl at least one of R^2 , R^3 and R^4 is an electron-withdrawing substituent;
 wherein R^5 and R^6 , which may be the same or different,
 30 each is hydrogen, halogeno or alkyl of up to 6 carbon atoms, ;
 wherein R^7 is alkyl or halogenoalkyl each of up to 6 carbon atoms;
 and wherein R^8 is carbamoyl, alkyl, cycloalkyl, alkenyl,
 35 alkynyl, halogenoalkyl, halogenoalkenyl, halogenoalkynyl

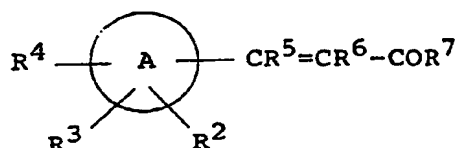
or alkanoyl each of up to 6 carbon atoms, or alkyl-carbamoyl or dialkylcarbamoyl wherein each alkyl is of up to 6 carbon atoms, or aroyl of up to 10 carbon atoms;

- 5 or wherein R^8 is alkyl or alkenyl each of up to 6 carbon atoms which bears one or more substituents selected from cyano, carbamoyl, amino and hydroxy, alkanoyl, alkoxy, alkylthio, alkenylthio, alkylsulphinyl, alkenylsulphinyl, alkylsulphonyl, alkenylsulphonyl, alkanoylamino, alkoxy-carbonylamino and alkylsulphonamido
 10 each of up to 6 carbon atoms, alkylamino, dialkylamino and dialkylsulphamoyl wherein each alkyl is of up to 6 carbon atoms, aroyl, aryl, arylthio, arylsulphinyl and arylsulphonyl each of up to 10 carbon atoms and
 15 heterocyclylthio, heterocyclylsulphinyl and heterocyclylsulphonyl;
 or wherein R^8 has the formula



- wherein ring B is phenyl, naphthyl or heterocyclyl and wherein R^2 , R^3 and R^4 have any of the meanings stated
 25 above, provided that when R^7 is methyl R^8 is not also methyl, characterised by:-

(a) for the manufacture of an alkene wherein R^1 is hydroxy and X is $-CR^5=CR^6-$, the reaction of a compound of the formula:



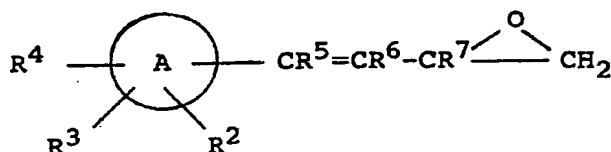
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wherein A, R², R³, R⁴, R⁵, R⁶ and R⁷ have the meanings stated above, with an organometallic compound of the formula R⁸-M, wherein R⁸ has the meaning stated above and M is a metallic group; or

10

(b) for the manufacture of an alkene wherein R¹ is hydroxy, X is -CR⁵=CR⁶-, and R⁸ has the formula -CH₂R⁹, the reaction of an epoxide of the formula:

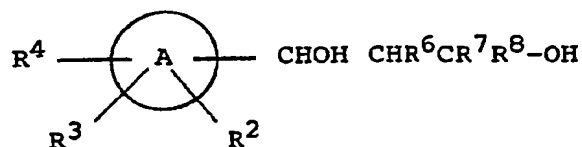
15



20 wherein A, R², R³, R⁴, R⁵, R⁶ and R⁷ have the meanings stated above, with a compound of the formula R⁹-H, wherein R⁹ is such that -CH₂R⁹ has the meaning stated above for R⁸; or

25

(c) for the manufacture of an alkene wherein R¹ and R⁵ are both hydrogen and X is -CH=CR⁶- the dehydration of a compound of the formula

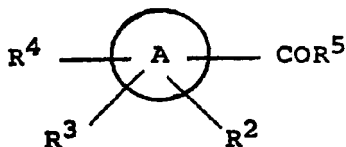


30

wherein A, R², R³, R⁴, R⁶, R⁷ and R⁸ have the meanings stated above; or

35

(d) for the manufacture of an alkene wherein R¹ is hydroxy and X is -CR⁵=CR⁶-, the reaction of a compound of the formula

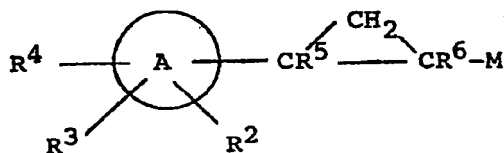


wherein A, R², R³, R⁴ and R⁵ have the meanings stated above, with a compound of the formula



wherein R⁷ and R⁸ have the meanings stated above; or
(e) for the manufacture of a cycloalkylene

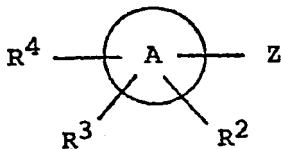
derivative wherein X is $\begin{array}{c} \text{CH}_2 \\ \diagup \quad \diagdown \\ -\text{CR}^5 \quad \text{CHR}^6 \end{array}$, the reaction of
a compound of the formula



wherein A, R², R³, R⁴, R⁵, R⁶ and M have the meanings stated above, with a compound of the formula



wherein R⁷ and R⁸ have the meanings stated above; or
(f) for the manufacture of an alkyne wherein X is
-C≡C-, the reaction of a compound of the formula



wherein A, R¹, R², R³ and R⁴ have the meanings stated

above and wherein Z is a displaceable group, with a compound of the formula



5

wherein R^1 , R^7 and R^8 have the meanings stated above;

whereafter a compound wherein X is $-\text{C}=\text{C}-$ may be reduced to the corresponding compound wherein X is $-\text{CH}=\text{CH}-$; and whereafter

10 (i) a compound wherein R^8 bears an amino substituent may be acylated to give the corresponding compound wherein R^8 bears an alkanoylamino, alkoxycarbonylamino, or alkylsulphonamido substituent;

15 (ii) a compound wherein R^8 is alkyl containing an alkylthio and an alkylsulphinyl substituent on the same carbon atom may be converted to the corresponding compound wherein said carbon atom is a carbonyl group;

(iii) a compound wherein R^8 is alkanoyl or is alkyl substituted by alkanoyl may be reduced to the
20 corresponding compound wherein R^8 is hydroxyalkyl; or
(iv) a compound wherein R^8 is alkynyl may be converted to the corresponding compound wherein R^8 is alkanoyl by hydration by conventional means;

(v) a compound wherein R^1 is alkyl may be prepared
25 by the alkylation of the corresponding compound wherein R^1 is hydrogen;

(vi) a compound wherein R^1 is alkanoyl or aroyl may be prepared by the acylation of the corresponding compound wherein R^1 is hydrogen; or

30 a compound wherein one or more of R^2 , R^3 , R^4 and a substituent in R^8 is alkyl-sulphinyl or alkylsulphonyl, or a substituent in R^8 is alkenylsulphinyl, arylsulphinyl, alkenylsulphonyl, arylsulphonyl, heterocyclylsulphinyl or heterocyclyl-

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sulphonyl, may be prepared by the oxidation of the corresponding compound wherein one or more of R^2 , R^3 , R^4 and a substituent in R^8 is alkylthio, alkenylthio, arylthio or heterocyclylthio, respectively.

2. A process as claimed in claim 1 wherein in the starting materials X is $-CR^5=CR^6-$, ring A is phenyl, wherein one or two (the same or different) of R^2 , R^3 and R^4 are fluoro, chloro, cyano, trifluoromethyl or nitro, the others of R^2 , R^3 and R^4 being hydrogen, R^1 , R^5 and R^6 are all hydrogen, R^7 is trifluoromethyl, pentafluoroethyl, heptafluoropropyl, chloromethyl or dichloromethyl, R^8 is methyl, ethyl, n-propyl, isopropyl, n-butyl, cyclopropyl, cyclopentyl, trifluoromethyl, chloromethyl, dichloromethyl, ethynyl, chloroethynyl, acetyl or propionyl or is methylene ($-CH_2-$) substituted by cyano, hydroxy, carbamoyl, formyl, acetyl, alkylthio, alkenylthio, alkylsulphonyl or alkenylsulphenyl each of up to 6 carbon atoms, phenylthio or phenylsulphonyl which itself is unsubstituted or bears a fluoro, chloro, nitro, carbamoyl, acetamido, methylthio or methylsulphonyl substituent, pyridyl, quinolyl, pyrimidinyl, purinyl, pyrazolopyrimidinyl, thiazolyl, imidazolyl or triazolyl any of which is unsubstituted or bears a hydroxy, mercapto, amino, chloro, trifluoromethyl or methyl substituent, and wherein the $-CR^5=CR^6-$ group is in the trans- configuration.

3. A process as claimed in claim 1 wherein in the starting materials X is trans- $-CH=CH-$, wherein ring A is 3,4-dichlorophenyl, 3-chloro-4-cyanophenyl, 3-chloro-4-fluorophenyl, 4-chloro-3-trifluoromethylphenyl, 4-cyanophenyl, 4-cyano-3-fluorophenyl, 4-cyano-3-trifluoromethylphenyl or 4-fluoro-3-trifluoromethylphenyl, R^1 is hydrogen, R^7 is trifluoromethyl and R^8 is ethyl, ethynyl,

5 cyanomethyl, 1-cyanoethyl, acetyl, methylsulphonyl-methyl, p-methylsulphonylphenylsulphonylmethyl or pyrid-2-ylsulphonyl, or has the formula $-CH_2SR^9$ wherein R^9 is m-methylthiophenyl, pyrid-4-yl, pyrimid-2-yl, 4,6-dimethylpyrimid-2-yl, purin-6-yl, 1H-pyrazolo-[3,4-d]pyrimidin-4-yl, imidazol-2-yl, 1-methylimidazol-2-yl, 7-chloroquinolin-4-yl or 7-trifluoromethyl-quinolin-4-yl.

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